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ENGINEERS

Color Negative-Positive

Multiple-Image Photography

High-Speed Optical Problems

Multiple Echoes in Television

The Image Iconoscope

TelePrompter

Synchro-screen

Resolution Test Chart

Laboratory Practice Report

THIS ISSUE IN TWO PARTS
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The Ansco Color Negative-Positive Process

By HERMAN H. DUERR

The basic principles of the Ansco Color Negative-Positive Process are outlined. The paper deals with the essential characteristics of the color film materials used for the process and outlines the printing and processing steps required. Methods used to comply with the requirements of the motion picture industry in regard to color dupes for optical effects, protection masters, color negative master dupes, and color release printing are described. Requirements of sound and procedures to produce silver sound tracks are discussed.

In 1945,[1] the Ansco Color Process for professional motion pictures was proposed. This process was based on the principle of reversible development of monopack materials. Several motion pictures have been produced using this process. It was realized, however, that a color process using the negative-positive approach would be preferable for a number of reasons. In the first place, such a process would follow more closely the long established black-and-white practices of the motion picture industry. More important, however, a color film process using the negative-positive cycle is superior due to the higher speed attainable and the considerably greater latitude in exposure, processing and printing.

The Color Negative-Positive process, however, presented many problems, particularly in regard to methods of providing dupes for optical effects, protection masters and other essential requirements for the production of feature motion pictures. These problems have now been satisfactorily solved and the Ansco Color Negative-Positive process will now replace the older process using film types 735 and 732, requiring reversible development.

The Ansco Color Negative-Positive Process, like the earlier reversal process, is a subtractive color process, using the principle of color-forming development.

There are three different 35mm color film materials involved in the process:

Color Negative Film Type 843,
Color Dupe Negative Film Type 846, and
Color Positive Release Printing Film Type 848.

In addition to these color film materials, a panchromatic fine grain dupe film, such as the Eastman Panchromatic Sepa-

Presented on October 18, 1951, at the Society's Convention at Hollywood, by Herman H. Duerr, Ansco Division of General Aniline & Film Corp., Binghamton, N.Y.

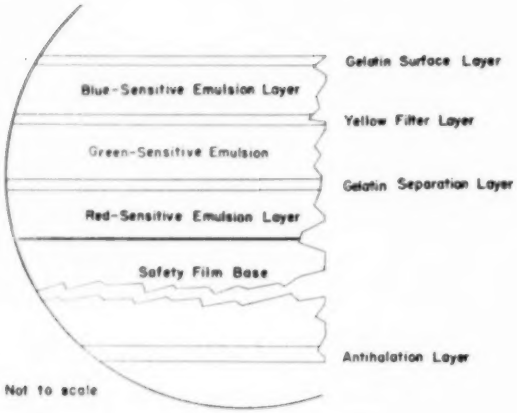


Fig. 1. Scheme of layer arrangement of Ansco Color Negative, Type 843, before processing.

ration Film, Type 5216, can be used for making separations.

The three multilayer color film types used in the negative-positive cycle are similar in structure, although quite different in other characteristics.

Figure 1 shows the layer arrangement typical for the three color film types used in the process. The conventional layer arrangement, with a red-sensitive bottom layer, a green-sensitive middle layer and a blue-sensitive top layer, is being used. This figure illustrates the Color Negative Film Type 843 before processing.

As has been described before,[2] the three colors, cyan, magenta and yellow, in the Ansco Color Process are formed in their respective layers during *one* color developing step. It is one of the important characteristics of the Ansco Color Process that the noncliffusing, colorless color couplers are dissolved and uniformly distributed in the gelatin of the photographic emulsion layers and completely surround the individual light-sensitive silver halide grains. After exposure and during the color development, the developing agent becomes partially oxidized by reducing exposed silver halide grains to metallic silver. The partially oxidized developing agent reacts with the color couplers to form dye deposits. The oxidized color developing agent is soluble and can move freely in the layer. In order to produce a dye image in closest proximity with the originally exposed grain, it is, therefore, important that the color coupler surround the silver halide grain so that the coupling reaction can take place truly *in situ* with the silver halide grain. This characteristic of the Ansco Color Process is important and is responsible

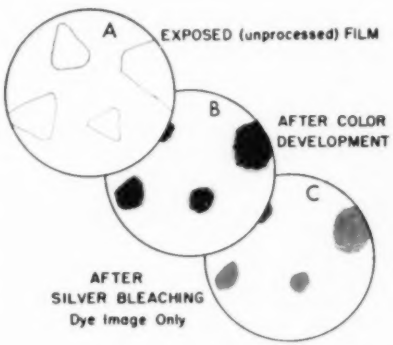


Fig. 2. Scheme of three stages in the processing of Ansco Color Film:
A. Silver halide grain before color development;
B. Silver grain after color development; and
C. Grain after silver bleach

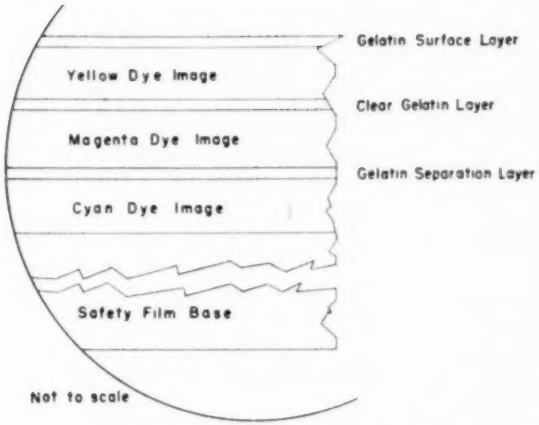
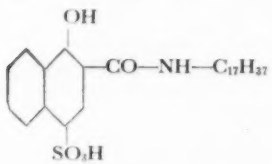


Fig. 3. Scheme of color negative layers after color processing.

for the good image sharpness and definition.

A schematic illustration of the mechanism of dye image formation taking place in closest proximity to the exposed silver halide grains is shown in Fig. 2. The Ansco color couplers are immobilized in the emulsion layers by means of the specific chemical configuration of the color coupler molecules. To provide the characteristics of complete solubility and at the same time immobility and nondiffusing properties, the molecular structure has been arranged in such a way that a fatty acid molecule of large molecular size, through a short linkage, is chemically combined with the dye coupler molecule.[3] The fatty acid molecule acts somewhat like an anchor, preventing the diffusion of the dye coupler and of the formed dye image within the layer, as well as from one layer to another.

A typical cyan colorformer of this configuration, with substitution referred to as "fat-tail," is:



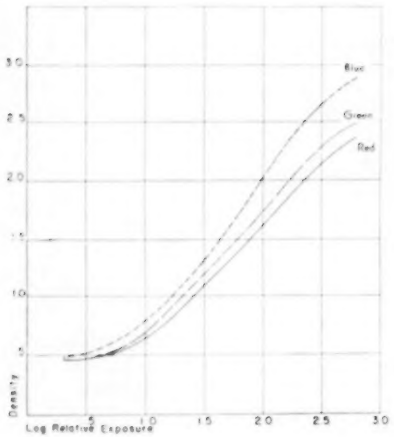
Ansco Color Negative Film, Type 843

Camera Requirements: The Ansco Color Negative Film, Type 843, can be exposed in conventional motion picture cameras as they are used for black-and-white photography. The only additional requirement is that, for maximum image definition, the lenses used should have good color correction.

Film Characteristics: The layer arrangement of the Color Negative Film, Type 843, before processing has been shown in Fig. 1. The layers after processing are shown in Fig. 3.

More recently the Type 843 film has been supplied on gray base instead of on clear base with the soluble antihalo back layer, and results regarding halation in motion picture practice have been quite satisfactory. The gray base does not interfere with the subsequent printing operations and the absence of a soluble back layer on the negative film has certain advantages in processing.

Sensitometry: The sensitometric curves of the three emulsion layers of the Color Negative Film, Type 843, are illustrated in Fig. 4. When developed to the proper contrast for direct printing on Color Positive, Type 848, or for the preparation of black-and-white tricolor



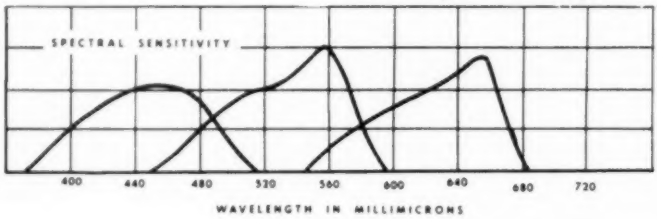
separations, the gamma values for the three layers, measured as integral densities on the Macbeth-Ansco Color Densitometer Model 12, should be approximately as follows:

Blue-sensitive layer (yellow) . .	1.25
Green-sensitive layer (magenta) .	1.00
Red-sensitive layer (cyan) . . .	1.00

Spectral Sensitivity: The spectral sensitivity of the color negative film is shown in Fig. 5. The sensitivity peaks are at 450, 555 and 655 mμ, respectively. The film is balanced for light of daylight

Fig. 4. Integral density curves of color negative film, Type 843.

Fig. 5. Spectral sensitivity of color negative film, Type 843.



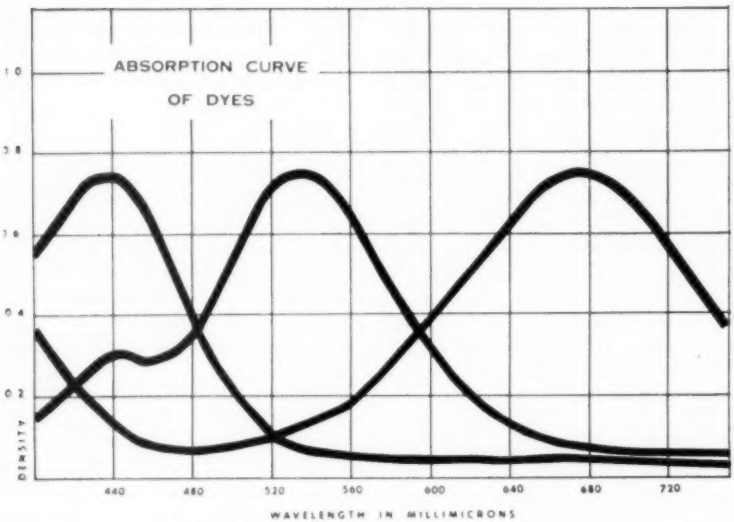


Fig. 6. Absorption characteristics of color negative film, Type 843.

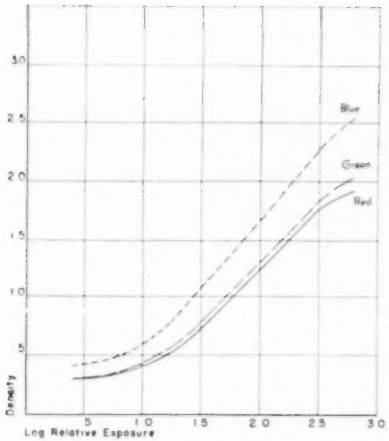


Fig. 7. Integral density curves of color dupe negative film, Type 846.

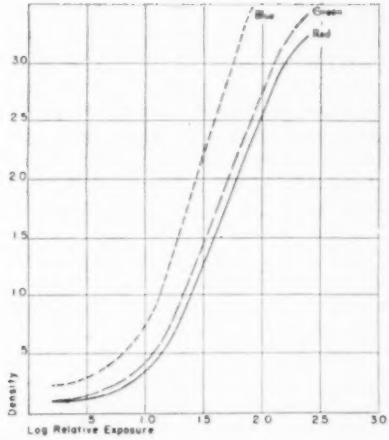


Fig. 8. Integral density curves of color positive release printing film, Type 848.

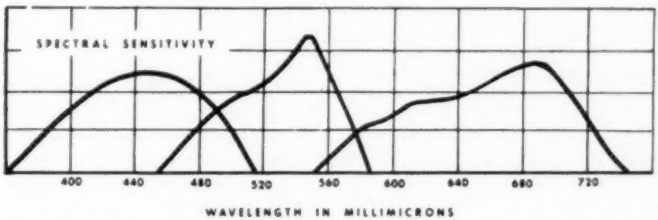


Fig. 9. Spectral sensitivity of color positive printing film, Type 848.

quality. For interior illumination the overall color balance should be approximately 5400 K. While the overall color balance is not critical, it is important that the different light sources on a set be balanced to the same spectral quality. The use of ultraviolet filters, such as Ansco UV-16 or Wratten Filter No. 1, for outdoor exposures and indoor exposures with arc lights is recommended.

Absorption Characteristics: The dye images recorded in the color negative film are in colors complementary to the colors of the original. The absorption characteristics of the dyes in the color negative film are illustrated in Fig. 6. The absorption maxima are: yellow, 440 mμ, magenta, 540 mμ and Cyan, 675 mμ.

Sensitivity and Resolving Power: The color negative film has an exposure index of 16. The resolving power, as measured by the method proposed by Sayce,[4] is 44–48 lines/mm.

Ansco Color Duplicating Negative Film, Type 846

Film Characteristics: The Color Dupe Negative Film is similar to the Color Negative Film Type 843 in layer arrangement and color absorption characteristics. However, the color sensitivity is

different from that of Type 843, but it is similar to that of the Color Positive Film Type 848, as shown in Fig. 9. In order to produce dupe negatives with fine grain and good resolution, the emulsions used for this film type are much slower. The exposure index is approximately 0.6 to 1.0. This film type is also on gray base of the density of the Negative Type 843 so that it can be readily interspliced with it. The resolving power is approximately 66 lines/mm. The sensitometric characteristics of the color dupe negative film are shown in Fig. 7.

The color dupe negative film is used to make color negative dupes from tricolor separation positives made from the color negative originals. Optical effects, fades, lap dissolves and other special effects can be introduced via these color dupe negatives. The various methods which can be used to obtain a color positive release print will be described later, below.

Ansco Color Positive Release Printing Film, Type 848

Film Characteristics: In emulsion layer arrangement the color positive release printing film is similar to the color negative film shown in Fig. 1. The color positive film can be exposed either directly from color negative originals, from color negative dupes or from black-and-white tricolor separation negatives. The sensitometric curves of the individual layers of the color positive film, plotted as integral densities, are shown in Fig. 8. In Fig. 9 the spectral sensitivity of the color positive printing film is illustrated. Good separation of the spectral sensitivity ranges with a minimum of overlaps is desirable for good color reproduction in the printing film.

Dye Absorption: The absorption characteristics of the dyes produced in the color positive film are different from those in the color negative and dupe negative film. The absorption maxima are: 440 mμ for the yellow layer, 540 mμ for the magenta layer, and 660 mμ for the cyan layer.

Film Speed and Resolving Power: The sensitivity of the color positive film is similar to black-and-white positive, approximately exposure index 1.5. The resolving power is 64–66 lines/mm.

All three color film types used in the Ansco Color Negative-Positive Process are on low-shrink, safety base.

Color Processing Procedures and Solutions

The three color film types used in the process require very similar processing steps and processing solutions. Only the Color Negative Film, Type 843, requires a different color developing solution. The color dupe negative film and the color positive release printing film can be developed in the same solutions throughout. The color developing time of these two types is different, as shown in Table I.

For uniform processing of all types of color film materials good control of the processing solutions at all times is very important. Basic control procedures which apply also to the handling of color negative-positive have been described by Bates and Runyan,[5] while analytical procedures to control and maintain solution strength and uniformity have been presented by Brunner, Means and Zappert.[6] General information in regard to color sensitometry may be found in the report of the SMPTE Color Sensitometry Subcommittee.[7]

Methods of Release Printing From Ansco Color Negatives

Methods of release printing from Ansco color negatives for the printing of Ansco color negative originals from different methods and certain variations thereof can be used to produce color positive release prints. These methods are summarized in Fig. 10.

Not all of these methods are equal in regard to color quality and cost. A more detailed discussion of the ad-

Table I. Processing Steps and Materials for the Three Color-Film Types Used in the Ansco Color Negative-Positive Process.

	Neg. Type 843, min	Neg. Dupe Type 846, min	Pos. Type 848, min
Alkaline pre-bath*	—	—	2
Jet rinse	—	—	30 sec
Color developer (608)	10–12	6–7	—
Color developer (609)	—	—	11–14
Rinse (859B)	30 sec	30 sec	30 sec
Hardening fixer (804)	8	8	8
Wash	4	4	4
Bleach (715A)	6	6	6
Wash	4	4	4
Fixer (800)	8	8	—
Wash	6	6	—
Dry	25	25	—

*The alkaline pre-bath prepares the alkali-soluble antihalo layer for removal by the jet rinse.

Air squeegeeing and edge treatment of sound track (silver track)	30 sec
Wash	2 min
Final fix (800)	4 min
Wash	8 min
Stabilizing bath	2 min
Rinse	1 sec
Dry	25 min

Processing Formulas

Ansco Color Negative Developer 608

Water (60–70 F)	900 ml
Hexametaphosphate (Calgon or Nullapon BFC)	1 g
Sodium sulfite (Na_2SO_3)	3 g
Ansco S-5 Color Developing Agent	7 g
Sodium carbonate ($Na_2CO_3 \cdot H_2O$)	75 g
Sodium sulfate (anhydrous)	30 g
Potassium bromide (KBr)	2 g
Ansco DA-1 Accelerator Solution (5%)	5 ml
Potassium iodide (KI)	3 mg
Water to	1 l

(Developing time for 843, 10–12 min at 68 F)

#122A Replenisher for Ansco Color Developer #608

Water (60–70 F)	750 ml
Hexametaphosphate (Calgon or Nullapon BFC)	1 g
Sodium sulfite (Na_2SO_3)	3.75 g
Ansco S-5 Color Developer Salt	11 g
Sodium carbonate ($Na_2CO_3 \cdot H_2O$)	75 g
Sodium sulfate (anhydrous)	30 g
Potassium bromide (KBr)	1 g
Ansco DA-1 Accelerator Solution	6 ml
Sodium hydroxide (NaOH) approx.*	2 g
Water to	1 l

*The hydroxide content is adjusted to obtain a pH 0.45 higher than that of a fresh mix of 608 Developer.

(A representative replenishment rate is 11 1/1000 ft of 35mm Color Negative Type 843.)

Ansco Color Developer 609

Water (60–70 F)	900 ml
Hexametaphosphate or Nullapon BFC	1 g
Sodium sulfite (Na_2SO_3)	2 g
Ansco S-5 Color Developing Agent	5 g
Sodium carbonate ($Na_2CO_3 \cdot H_2O$)	60 g
Potassium bromide (KBr)	1 g
Potassium iodide	1 mg
Water to	1 l

Normal pH approx. 10.5, as determined with Beckman Model G pH meter with long-range electrode type 42 or equivalent.

Developing time for 846, 6–7 min at 68 F.

Developing time for 848, 11–14 min at 68 F.

Continued on the following page.

Table I—Concluded.

#100C Replenisher for Ansco Color Developer #609

Water (60–70 F)	750 ml
Hexametaphosphate	1 g
Sodium sulfite (Na_2SO_3)	3 g
Ansco S-5 Color Developer Salt	7.5 g
Sodium carbonate ($Na_2CO_3 \cdot H_2O$)	60 g
Sodium hydroxide (NaOH) approx.*	2 g
Water to	1 l

* The hydroxide content is adjusted to obtain a pH 0.4 higher than fresh mix of #609 developer.

A representative replenishing rate is 11 l/1000 ft of 35mm Color Negative Type 843.

Rinse (859B)

Acetic acid (glacial)	3 ml
Sodium acetate (anhydrous)	30 g
Water to	1 l

pH fresh *about* 5.4

Replenisher (858)

Acetic acid (glacial)	10 ml
Sodium acetate (anhydrous)	20 g
Water to	1 l

Replenish continuous to maintain pH 5.4 to 5.8.

Hardening Fixer (804)

Water	750 ml
Chrome alum [$KCr(SO_4)_2 \cdot 12H_2O$]	30 g
White alum [$KAl(SO_4)_2 \cdot 12H_2O$]	20 g
Sodium acetate (anhydrous)	10 g
Sodium sulfite (anhydrous)	10 g
Hypo ($Na_2S_2O_3 \cdot 5H_2O$)	200 g
Water to	1 l

pH = 4.0

Bleach (715A)

Water	750 ml
Hexametaphosphate	1/2 g
Potassium ferricyanide	100 g
Sodium acetate (anhydrous)	40 g
Acetic acid (glacial)	2.25 ml*
Water to	1 l

* Vary to adjust to pH 4.5–4.7.

Fixer (800)

Water	750 ml
Sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$)	200 g
Water to	1 l

Stabilizer

2% solution of formaldehyde

Sound Track Developer

Solution A

DA-5	1 g
Metol	20 g
Sodium sulfite (anhydrous)	40 g
Hydroquinone	20 g
Sodium thiosulfate	3 g
Formalin (37%)	20 ml
Water to	1 l

Solution B

Thickener (Cellosize) Stock Solution

Hydroxyethyl cellulose (WP40)	45 g
Water to make	1 l

For use: Add 100 ml of Solution B to 900 ml Solution A and add 200 cc of Thickener Stock Solution.

vantages and disadvantages of each of these methods is, therefore, in order.

Method A. Printing From Original Color Negatives Interspliced With Opticals on Color Dupe Negatives

This method, shown schematically in Fig. 11, comes closest to present black-and-white practices, at least as far as domestic releases are concerned. The color negative originals, which may represent 60–75% of the total footage, are interspliced with optical effects such as fades, lap dissolves, etc., made on Color Dupe Negative Film Type 846 Tricolor separations on Fine Grain Duplicating Pan Film are made from the full-length negative. They are used as protection masters. The optical effects are produced from sections of

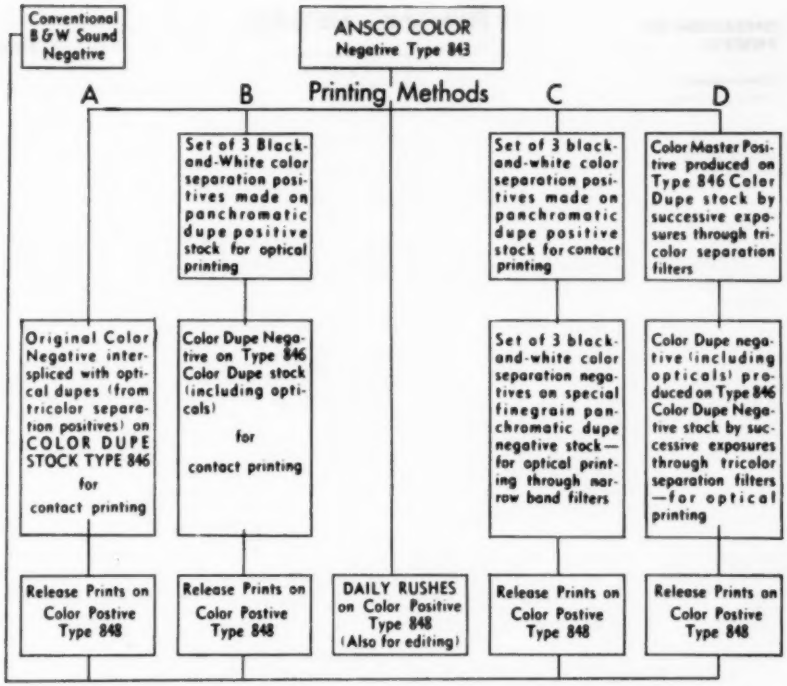

Conventional B & W Sound Negative
ANSCO COLOR Negative Type 843
A
B
Printing Methods
C
D
Set of 3 Black-and-White color separation positives made on panchromatic dupe positive stock for optical printing
Set of 3 black-and-white color separation positives made on panchromatic dupe positive stock for contact printing
Color Master Positive produced on Type 846 Color Dupe stock by successive exposures through tricolor separation filters
Original Color Negative interspliced with optical dupes (from tricolor separation positives) on COLOR DUPE STOCK TYPE 846 for contact printing
Color Dupe Negative on Type 846 Color Dupe stock (including opticals) for contact printing
Set of 3 black-and-white color separation negatives on special finegrain panchromatic dupe negative stock—for optical printing through narrow band filters
Color Dupe negative (including opticals) produced on Type 846 Color Dupe Negative stock by successive exposures through tricolor separation filters—for optical printing
Release Prints on Color Postive Type 848
Release Prints on Color Postive Type 848
DAILY RUSHES on Color Positive Type 848 (Also for editing)
Release Prints on Color Postive Type 848
Release Prints on Color Postive Type 848

Fig. 10. Summary of methods which can be used for release printing.

these black-and-white separations by printing on Color Dupe Negative Film Type 846. Method A, which involves a minimum of color printing by the use of color negative originals except for opticals and effect shots, leads to the best color quality. This method would be first choice for domestic releases.

Method B. Printing From Full-Length Master Dupe Negatives

In Method B, as shown in Fig. 12, release printing is done from master color dupe negatives. This method is recommended where the original color negatives cannot be made available for release printing. This is frequently the case for foreign releases. Tricolor separations on panchromatic duplicating film are made from the cut negative. Master color dupe negatives on Type 846 are made from all scenes, including opticals and special effects. Scene-to-scene conformance can be attempted in making the separations, as well as in printing the master dupe negatives, so that only minor color balance and light corrections have to be made during the release printing steps. The black-and-white separations also serve as protection masters.

As in Method A, the release printing is done by contact printing. In both methods conventional equipment, such as a Model D or Model E Bell & Howell or similar printers, can be used.

The filters required to correct for the overall and scene-to-scene color balance variations in printing are determined by the use of a color scene tester similar to the one described by F. P. Herrnfeld.[8]

On the Model D printer provisions

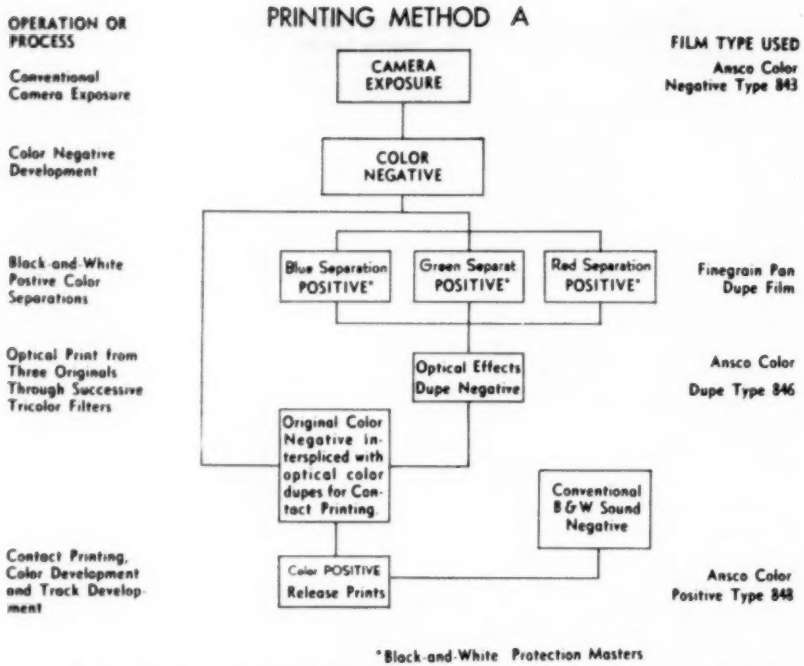

PRINTING METHOD A
OPERATION OR PROCESS
FILM TYPE USED
Conventional Camera Exposure
CAMERA EXPOSURE
Ansco Color Negative Type 843
Color Negative Development
COLOR NEGATIVE
Black-and-White Postive Color Separations
Blue Separation POSITIVE*
Green Separat POSITIVE*
Red Separation POSITIVE*
Finegrain Pan Dupe Film
Optical Print from Three Originals Through Successive Tricolor Filters
Optical Effects Dupe Negative
Ansco Color Dupe Type 846
Original Color Negative interspliced with optical color dupes for Contact Printing.
Conventional B & W Sound Negative
Contact Printing, Color Development and Track Development
Color POSITIVE Release Prints
Ansco Color Positive Type 848
*Black-and-White Protection Masters

Fig. 11. Method A: Printing from original color negatives interspliced with opticals on color dupe negatives.

should be available for the insertion of color balance filters.[8] Following a suggestion made by the Metro-Goldwyn-Mayer Laboratory, a special material for colored traveling mattes for the Model E Bell & Howell printer has been made available. Film base dyed uniformly to produce various color filter combinations, coated with positive finegrain emulsion, is exposed and processed by the Laboratory to produce a "variable width" type light control strip in the center of the film, as shown in Fig. 13.

Appropriate lengths of different colored matte negatives, representing the various light and color balance changes are spliced together. This colored traveling matte automatically corrects for scene-to-scene variations in color balance and density and the full speed of the printer can be utilized.

In the preparation of master color dupe negatives on Type 846 film, the following sensitometric conditions are representative:

Negative-Positive Duplication Control Gammas

	B	*G*	*R*
Color Negative Type 843	1.15	1.00	1.00
Separations*	0.75	0.75	0.75
Color Dupe Negative Type 846	1.20	1.10	1.10
Color Positive Release Print Type 848	3.00	2.70	2.70

Sensitometric test strips exposed with a light source approximately 3200 K, using an intensity scale sensitometer and measured on a Macbeth-Ansco Model 12 Color Densitometer.

* Black-and-white separations exposed on an Eastman Type IIb Sensitometer and measured on Western Electric RA-1100B Densitometer.

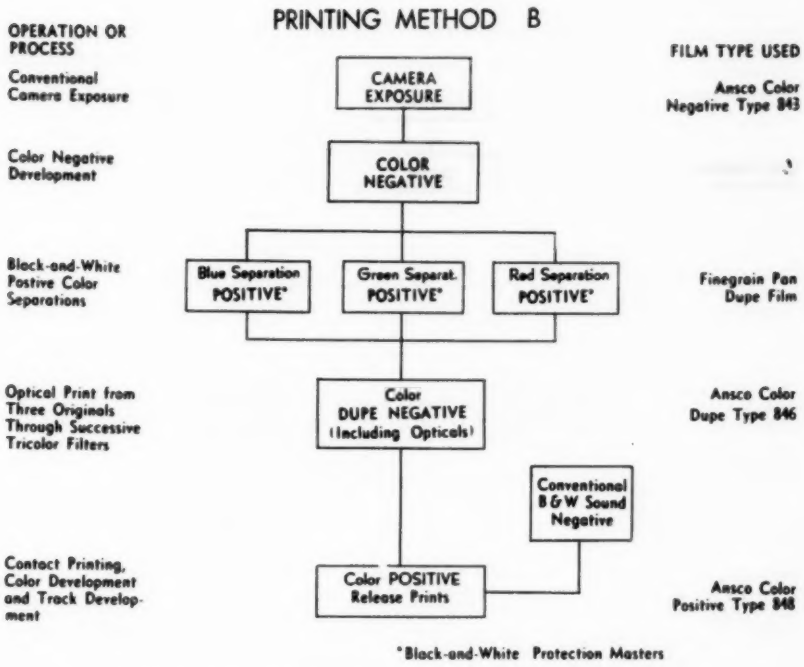

PRINTING METHOD B
OPERATION OR PROCESS
FILM TYPE USED
Conventional Camera Exposure
CAMERA EXPOSURE
Ansco Color Negative Type 843
Color Negative Development
COLOR NEGATIVE
Black-and-White Postive Color Separations
Blue Separation POSITIVE*
Green Separat. POSITIVE*
Red Separation POSITIVE*
Finegrain Pan Dupe Film
Optical Print from Three Originals Through Successive Tricolor Filters
Color DUPE NEGATIVE (Including Opticals)
Ansco Color Dupe Type 846
Conventional B & W Sound Negative
Contact Printing, Color Development and Track Development
Color POSITIVE Release Prints
Ansco Color Positive Type 848
*Black-and-White Protection Masters

Fig. 12. Method B: Printing from full-length master dupe negatives.

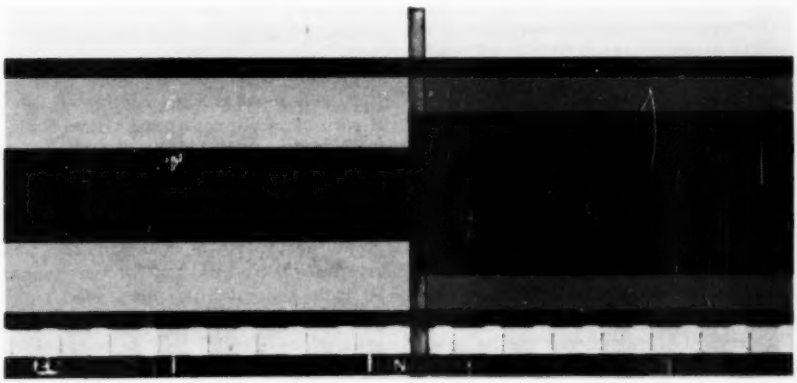


Fig. 13. Traveling matte for light and color balance control on Model E-type printer. Film on the left side of the splice is color correction filter density CC10Y. Film on right side is CC filter density 15M+0.05Y.

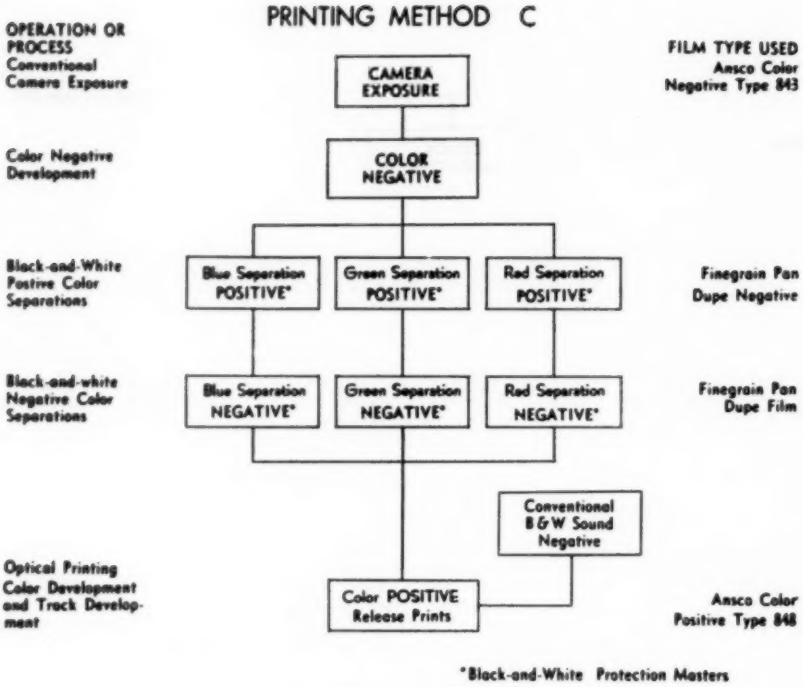


Fig. 14. Method C: Release printing from black-and-white separation negatives.

The method described next requires optical printing and is shown schematically in Fig. 14.

Method C. Release Printing From Black-and-White Separation Negatives

In Method C three-color separation positives on fine-grain Pan Duplicating Film are made from the color negative originals. These positives are printed on the same fine-grain duplicating film, this time developed to a lower gamma negative. Optical effects can be introduced during this printing step. The black-and-white three-separation negatives, including the optical effects, are used for release printing on Ansco Color Positive Film Type 848, preferably using multihead printers with good registration.

Method C avoids one color printing step as compared with Method B, and if very carefully controlled allows somewhat higher color brilliance. However, due to the fact that optical printers have to be used, the release printing is considerably slower and the method requires great accuracy in sensitometric and registration control, and for that reason is not generally recommended. A fourth method not requiring tricolor separations should also be mentioned. Although the color degradation produced by this printing Method D is definitely noticeable, results have been better than expected. This method is briefly outlined in Fig. 15.

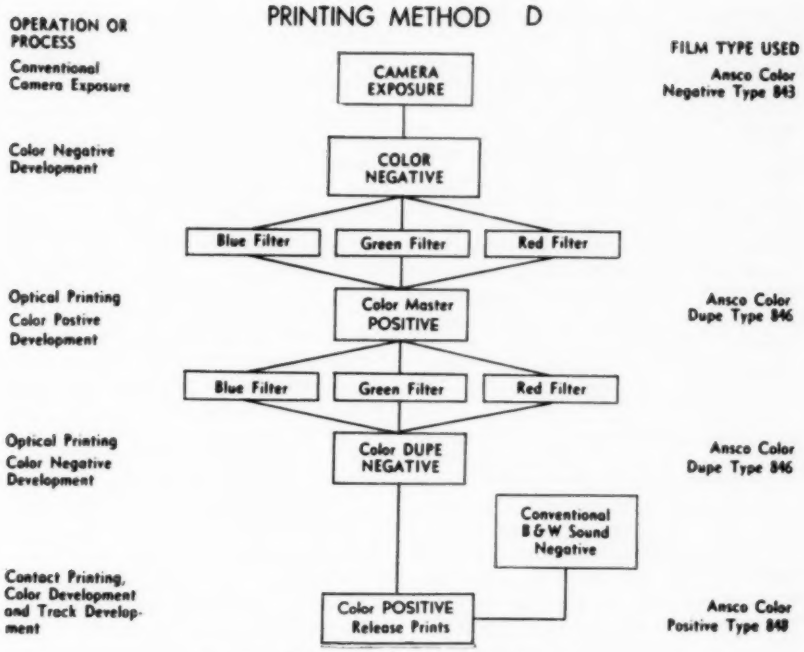


Fig. 15. Method D: Release printing from color dupe negatives via color dupe positives.

Method D. Release Printing From Color Dupe Negatives via Color Dupe Positives

In Method D color positive prints on Color Dupe Film Type 846 are made from the original color negatives using sharp cutting filters. The filters recommended are Ansco UV-16 for all printing steps in addition to the three-color separation filters:

Wratten Filter No. 70;
Wratten 16 plus Wratten 61; and
Wratten 23 plus Wratten 48A.

These filters are also recommended for making the three-color separations in Methods A, B and C.

The Color Dupe Film Type 846 is developed as a color positive. Optical effects can be introduced at this step or the next one, in which the color positive dupe is again printed on Color Dupe Stock 846 with the same sharp cutting filters. This time the 846 Film is developed as a low-contrast color negative. The contrast of this dupe negative should be kept as closely as possible to the same contrast as the original color negative. This second generation color dupe negative can be used for release printing on a conventional contact printer. The Method D does not provide for black-and-white protection masters. For this reason this method is not recommended for feature pictures. A description of this method has been included because there may be occasions where this procedure may offer certain advantages; also, the fact that color rendition is still quite acceptable is a good indication of the flexibility of the Ansco Color Negative-Positive Process.

Sound on Ansco Color Release Printing Film Type 848

The reproduction of sound from multilayer color films using developed dye images has for some time presented a problem, especially in connection with the red sensitive photocell, which is today the standard for 35mm motion picture projection.[9] In order to obtain a track which is efficient in absorption in the infrared region of the 868-type phototube, a method to produce a combination silver-plus-dye track having response characteristics similar to the conventional black-and-white silver tracks has been worked out.

Sound Track Development

As shown in Table I, the Color Positive Release Printing Film Type 848, after color development, fixing, bleaching and washing, is surface-dried by effective air squeegeeing. At this stage the sound track area carries a sound image consisting of a dye image from the original color developing step plus a silver ferrocyanide image, produced in the silver bleaching step. Using an applicator wheel or a pen-type applicator, a high viscosity rapid developer solution is applied to the sound track area only. This developer reduces the silver ferrocyanide-plus-dye sound image to a metallic silver + dye image. For the selective treatment of the sound track area, the following steps are important.

1. Effective air squeegeeing to remove surface moisture. The air squeegee should be close to the applicator station to prevent diffusion of moisture to the surface of the emulsion before developer solution is applied in the form of a bead covering the sound area only.
2. Application of high viscosity sound track developer, treating time approximately 30 sec.
3. To accelerate the development of silver track, infrared heat lamps at this stage are advantageous.

Cross-modulation and listening tests have indicated that variable-area sound negatives used for printing Color Positive 848 should have about the same densities as used for printing on black-and-white positive fine-grain film. Densities between 2.40 and 2.70, as read on a Western Electric RA-1100 Densitometer, are satisfactory. Sound printing with filtered light to confine the sound image to the two top layers is preferable. The top layer alone may be used for variable-area tracks.

The variable-area silver-plus-dye track of the edge-treated color positive film shows very good cancellation, fully equal to black-and-white tracks. The contribution of, and the effect of the dye image underlying the silver track image is insignificant in terms of the 868-type phototube response. A yellowish stain in the track area reduces the volume only by about 2 db.

Experience with variable-density recording is still somewhat limited, although satisfactory recordings have been made. In order to produce satisfactory gradation and resolution characteristics, the sound track should be confined to the two top layers, with equal contributions by both layers.

Acknowledgments

The development work reported in this paper represents the combined efforts of many people of the Ansco Research and Development Dept., as well as the Ansco technical staff in Hollywood. The valuable assistance of the Metro-Goldwyn-Mayer Laboratory, in particular J. M. Nickolaus, J. Arnold and D. Shearer, in cooperating on the various phases of the process and in supplying sample negatives and dupes for this presentation, is gratefully acknowledged.

References

1. H. H. Duerr and H. C. Harsh, "Ansco Color for professional motion pictures," *Jour. SMPE, 46:* 357–367, May 1946.

2. F. Wing, "Ansco Color Film," *Ansconian*, 3–11, Sept.–Oct. 1943. J. L. Forrest, "Machine processing of 16mm Ansco Color Film," *Jour. SMPE, 45:* 313–326, Nov. 1945.
3. W. Schneider, A. Fröhlich and H. Schultze, "Die diffusionsfesten Farbbildner des Agfacolor Films," *Chemie, 57:* 113–116 (DEZ.) 1944.
4. L. A. Sayce, *Photographic Journal, 80:* 454, 1940.
5. J. E. Bates and I. V. Runyan, "Processing control procedures for Ansco Color Film," *Jour. SMPE, 53:* 3–24, July 1949.
6. A. H. Brunner, Jr., P. B. Means, Jr., and R. H. Zappert, "Analysis of developers and bleach for Ansco Color Film," *Jour. SMPE, 53:* 25–35, July 1949.
7. A Report of the Color Sensitometry Subcommittee, "Principles of color sensitometry," *Jour. SMPTE, 54:* 653–724, June 1950. (Reprinted as a booklet.)
8. F. P. Herrnfeld, "Printing equipment for Ansco Color Film," *Jour. SMPTE 54:* 454–463, Apr. 1950.
9. R. Görisch and P. Görlich, "Reproduction of color film sound records," *Jour. SMPE, 43:* 206–213, Sept. 1944.
A. M. Glover and A. R. Moore, "Phototube for dye image sound track," *Jour. SMPE, 46:* 379–386, May 1946.
R. O. Drew and S. W. Johnson, "Preliminary sound recording tests with variable-area dye tracks," *Jour. SMPE, 46:* 387–404, May 1946.
A. B. Jennings, W. A. Stanton and J. P. Weiss, "Synthetic color-forming binders for photographic emulsions," *Jour. SMPTE, 55:* 455–476, Nov. 1950.
J. L. Forrest, "Metallic-salt track on Ansco 16mm Color Film," *Jour. SMPE, 53:* 40–49, July 1949.

Discussion

J. G. Frayne: Dr. Duerr mentioned a variable density track density of 0.85. This would be high for unmodulated density and would yield low level output. Do you propose using variable density tracks that are that dark?

H. H. Duerr: The density of 0.85 obtainable in the top layer alone referred to, is the maximum density. The unmodulated, unbiased operating density would, of course, be considerably lower and closely related to regular black-and-white practice. The best median density has to be established by further tests.

Dr. Frayne: Does this density figure 0.85, include the base?

Dr. Duerr: No. This is the maximum density obtainable in the top layer.

C. R. Daily: Do you intend to produce a tungsten-type film for use with a color temperature of approximately 3350 K?

Dr. Duerr: We are now producing only a film for daylight-type illumination, but expect to have a tungsten-type film available later on. Whether it will be balanced for 3350 K or a somewhat lower color temperature is not yet certain.

Frank E. Carlson: You referred to a color temperature of 5400 K for the negative film. Is the film balanced to the spectral emission of a black body radiator at that color temperature?

Dr. Duerr: Yes.

Richard H. Ranger: I have no question, but would like to compliment Dr. Duerr on his presentation, because the work shown here tonight represents great strides over the results demonstrated to a group of engineers in Wolfen shortly following the end of hostilities in Germany several years ago.

Multiple-Image Silhouette Photography for the NOTS Aeroballistics Laboratory

By ERNEST C. BARKOFSKY

A technique of multiple-image silhouette photography has been developed for the NOTS Aeroballistics Laboratory. Six or more silhouette images of missile models are imposed at a high rate upon a single photographic plate. A series of such plates is used in precision photogrammetry to determine the orientation and position of the models in transonic and supersonic flight. While neither stroboscopic nor silhouette photography is unique in itself, it is believed that the combination of the two, as described in this paper, is a new technique.

A TECHNIQUE of multiple-image silhouette photography has been developed by the Ballistics Division, Research Department, of the U. S. Naval Ordnance Test Station, Inyokern, for utilization in the NOTS Aeroballistics Laboratory. This technique is used in precision photogrammetry to determine the position and orientation of missile models in transonic and supersonic flight through the Laboratory. In order to obtain the desired accuracy in the aerodynamic and ballistic coefficients of the missile models, it is necessary that the mean deviation of a number of comparator measurements on the photographic images does not exceed a few ten-thousandths of an inch. It was found that this accuracy in measurement could be attained only by photographing the models in silhouette with microsecond-duration light flashes.

Considerations of economy and efficiency, however, demanded that a minimum of six silhouette images be recorded (at rates up to 3000/sec) on a single photographic plate; and experimental development of this technique has resulted in multiple-image silhouette photography of the desired quality.

Presented on October 16, 1951, at the Society's Convention at Hollywood, by Ernest C. Barkofsky, Ballistics Div., U.S. Naval Ordnance Test Station, Inyokern, China Lake, Calif.

The NOTS Aeroballistics Laboratory

The NOTS Aeroballistics Laboratory is a high-precision, enclosed range; an exterior view of the Laboratory is shown in Fig. 1. Inert missile models will be launched from a 3-in. gun and will pass through the 500-ft-long range building. The missiles will be photographed at 4-ft intervals during their flight, with photographic coverage provided by 23 pairs of precision ballistics cameras positioned so that the fields of view of

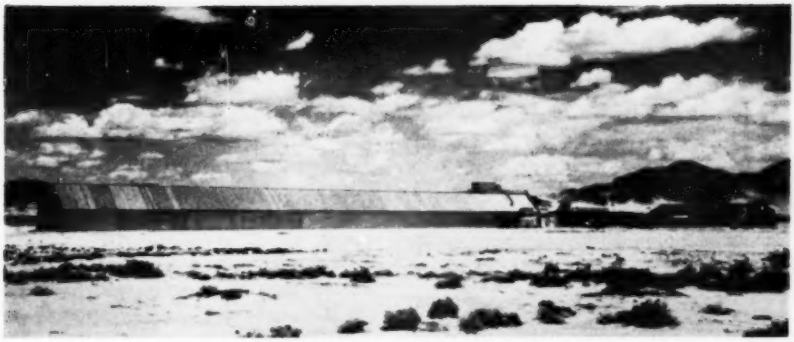


Fig. 1. The NOTS Aeroballistics Laboratory; Gun Platform and Control Room at right; Missile Stop at left.

adjacent cameras are overlapping. This relationship of the cameras is shown in Fig. 2. Each camera will photograph the missile six times, so that each photographic plate will bear six images for assessment. Figure 3 is a cross-sectional schematic drawing of the Aeroballistics Laboratory, and shows the orientation of the pair of cameras at each of the 23 Stations of the Laboratory. Figure 4 is a down-range view. Associated with each camera is a bank of three electrical-discharge flash lamps, the sources of microsecond-duration illumination of the missile models in transonic and supersonic flight. Much instrumentation was required to make possible the high-speed, multiple-image silhouette photography.

Instrumentation

The desired accuracy in the determination of the variation of position and orientation with time of the missile models to be studied in the Aeroballistics Laboratory imposed severe specifications in the performance requirements of the necessary instrumentation. In particular, detailed consideration had to be given to the many factors contributing to the errors of the photogrammetry: camera and lens; camera survey; photographic technique, including emulsion, developer and development combination; geometry of the camera-rocket model array; and exposure time and timing. An ultra-precision ballistics camera was designed and developed; a high-quality, wide-angle lens was selected for the camera; and a catenary system was designed to permit the calibration of the camera plates. A new photographic technique, that of multiple-image silhouette photography, was developed. The production of microsecond-duration flash illumination, precisely timed, required a complex electronic and electrical system including: (1) a photoelectric triggering system which provides for the start of the flash lamp illumination by the passage of the missile model through a light screen; (2) an electronic "gate" which stops the lamp flashing at each station after the rocket has passed from the field of view of the camera; (3) a light-flash counting system; (4) a master electronic timing system; (5) an electronic monitoring system: (6) a high-voltage power source; and (7) an electronic system for simulating the transonic and supersonic flight of a missile model through the Laboratory.

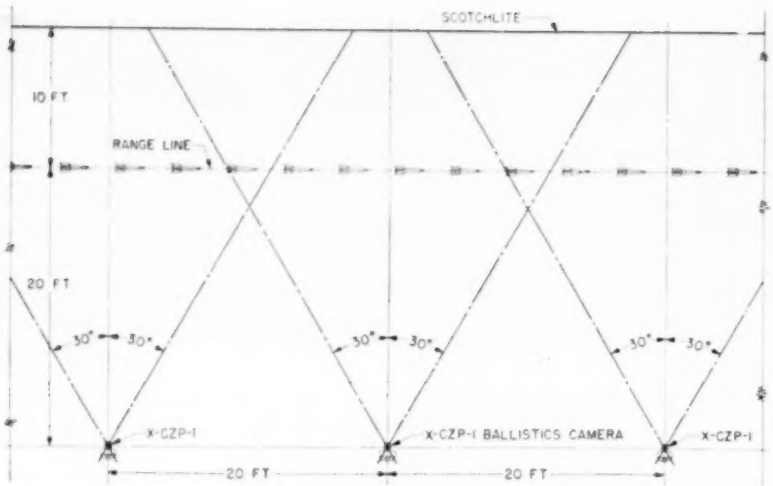


Fig. 2. 45° longitudinal schematic presentation of the NOTS Aeroballistics Laboratory.

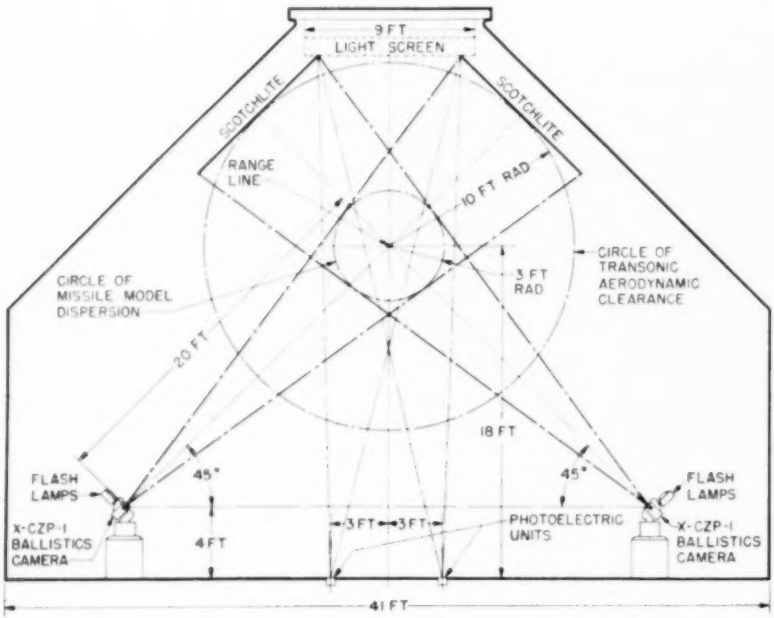


Fig. 3. Transverse schematic presentation of the NOTS Aeroballistics Laboratory.

Multiple-Image Silhouette Photography

The technique of multiple-image silhouette photography was developed expressly for use in the NOTS Aeroballistics Laboratory. Since the location of the transverse components of the center of gravity of the rocket model must be determined to within 0.001 ft, and since the magnification of the ballistics camera is 1/39th, measurements on the photographic plate must be made to within less than 0.0003 in. Because of the other factors which contribute to the error in the position determination, the accuracy of the comparator measurements on the photographic image may be only a fraction of the 0.0003 in. ($= 7.5\ \mu$). The accuracy of measurement possible with the best of comparators is of the order of one micron, hence the quality of the photographic image must be such that it in itself introduces practically no error. The characteristics of a photographic image which make possible precise comparator measurements upon it are sharply defined edges and proper contrast between the image of the object and the background against which it is photographed. It required but very little experimentation to reveal the fact that only by silhouette photography could satisfactory photographs be obtained of the highly polished missile models.

The photography of the missile models in silhouette at each four feet of their travel through the Aeroballistics Labora-

Fig. 4. Down-range view of the interior of the NOTS Aeroballistics Laboratory.

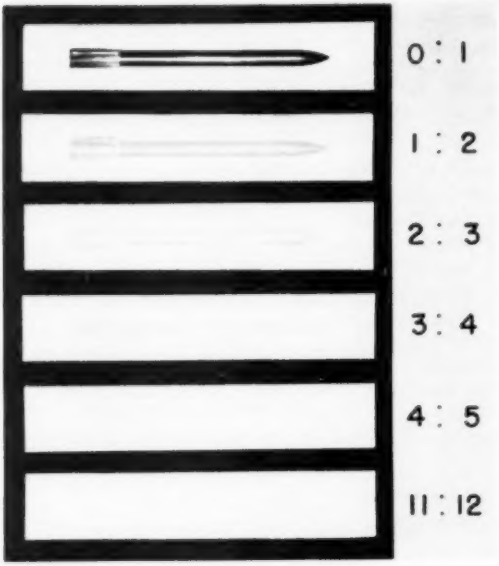


Fig. 5. Preliminary multiple-flash silhouette photographs, showing decrease in contrast with increase in number of superimposed flashes.

tory would have been impossible because of the instrumentation cost involved, if only one silhouette image on each photographic plate were possible. Investigation was therefore made of the feasibility of obtaining more than a single silhouette image on each plate. A serious difficulty with such a procedure is evident: each of N silhouette images on a single photographic plate will have $N - 1$ flash exposures of the bright background superimposed upon it, a condition that may result in very little or even no contrast between the silhouette images and the background. Exploratory work revealed, however, that even with an appreciable number of silhouette images on a single plate, discernable and even measurable images could be obtained. Figure 5 shows a series of photographs of a static model obtained with ever-increasing amounts of light superimposed upon the silhouette image. Measurements made by an inexperienced comparator operator upon one of the first of such a series of test exposures had the following values for the standard deviation of measurement for ten readings on each image:

Ratio of Silhouette Image Illumination to Background Illumination

	0:1	1:2	3:4	9:10
Std. deviation, μ	8.6	3.3	6.9	9.2

An interesting fact revealed by these preliminary measurements is that a true silhouette image (a negative with an opaque background and a transparent image) is less amenable to accurate measurement than an image with less contrast to the background. On the other hand, it is also evident that as the contrast is further decreased, accurate measurement again becomes difficult.

The decrease in contrast with increase in the number of superimposed light flashes is shown by manipulation of the simple equation of the straight-line portion of the photographic characteristic curve:

$$D = \gamma (\text{Log } E - \text{Log } i).$$

If $E = NF$,

where N = Number of flashes

and F = Energy per flash,

then $$D = \gamma (\text{Log } NF - \text{Log } i)$$

$$\Delta D = D_N - D_{N-1}$$

$$= \gamma \text{ Log } \frac{N}{N-1}$$

$$\propto \frac{1}{N-1} \quad \text{(within 10\% for } N = 6\text{)}.$$

This equation shows that the difference in density between a multiple-flash silhouette image and its background decreases as the total number of flashes is increased. Despite this predicted decrease in density difference, the technique of multiple-image silhouette photography has been developed to the degree that six-image photographs can

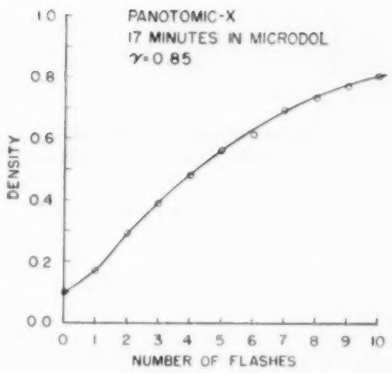


Fig. 6. Characteristic curve of emulsion-developer combination for multiple-image silhouette photography.

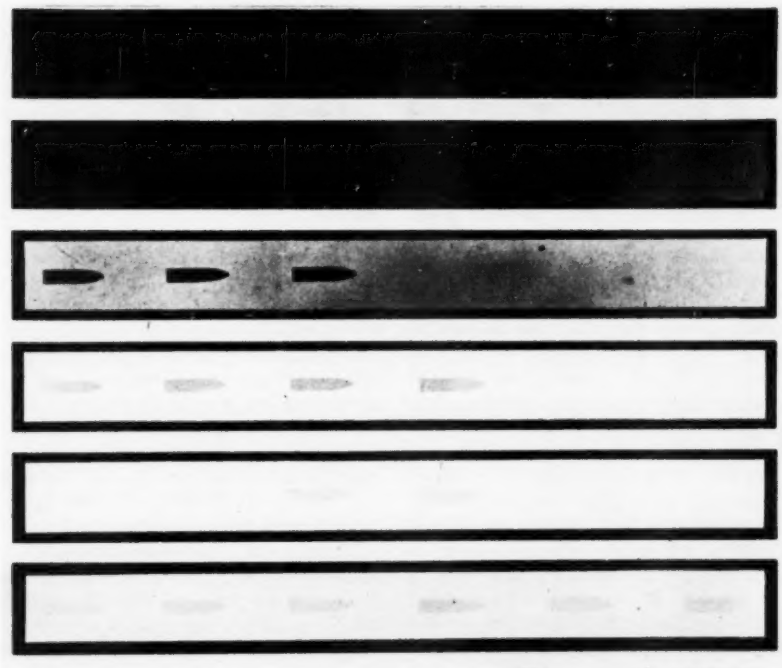


Fig. 7. Flash-by-flash development of six-image silhouette photograph in the NOTS Aeroballistics Laboratory.

Fig. 8. Five-image silhouette photograph of 20-mm projectiound. at 2800 ft/sec, flash rate of 2000/sec; Scotchlite backgrle in flight

be assessed with an accuracy of only a few microns.

This photography is done with Panatomic-X emulsion developed for 17 min in Microdol. Figure 6 is the characteristic curve obtained for this emulsion-developer combination under the conditions of flash photography in the Aeroballistics Laboratory.

Insufficient density was obtained with the use of flat-white paint or even movie screen as the silhouette background at the distance of 30 ft from the flash lamps, dictated by the geometry of the Aeroballistics Laboratory. It was found that No. 30 Wide-Angle Silver Scotchlite sheeting was very satisfactory for use as the silhouette background in the Aeroballistics Laboratory. By the use of Scotchlite, sufficient intensity was obtained with the superposition of six flashes on a single plate to yield negatives of satisfactory density. Figure 7 shows the flash-by-flash development of a six-image silhouette photograph.

Figure 8 is a high-speed, five-image silhouette photograph of a 20-mm projectile in flight at 2800 fps. This photograph is representative of those to be obtained in the NOTS Aeroballistics Laboratory.

Summary

The technique of multiple-image silhouette photography, when employed in conjunction with the instrumentation of the Aeroballistics Laboratory, permits the accurate determination of the aerodynamic and ballistic characteristics of missile models. The information concerning the performance of the models can be extrapolated for utilization in the design and development of improved missiles.

Optical Problems in High-Speed Camera Design

By JOHN C. KUDAR

CONCERNING THE optical theory of the rotating prism in high-speed cameras, there have been Letters to the Editor published in the *Journal* in July 1951. As the Letters dealt with more or less controversial interpretations of the problems involved in conventional high-speed camera design, I am glad to have this opportunity to expand upon the applications of the basic principles to the definite possibility of a promising and perhaps unexpected development in this field. It is necessary, however, to start with a survey of the existing commercial types.

The rotating polygonal prism as an optical component, such as a cube or an octagonal prism, is the generalized case of the rotating plane-parallel plate. One well-known high-speed camera is based on this principle of the plane-parallel plate. The image projected through the rotating plane-parallel plate moves with the same speed as the continuously traveling film, at least during the short exposure time. Another well-known camera differs in its optical construction in that the plane-parallel plate is replaced by a rotating cube or by an octagonal prism. In all cases the exposure is limited to small incidence angles by blacking edge pieces which act as shutters during the rotation.

Presented on October 16, 1951, at the Society's Convention at Hollywood, by John C. Kudar, 1809½ Las Palmas Ave., Hollywood 28, Calif.

The precise thickness of the plane-parallel plate (or polygonal prism) must be designed in accordance with the refractive index, as well as in consideration of the maximum incidence angle allowed for exposure. The correct mathematical formula for the thickness was well known long before the design of the first high-speed camera, since the principle of the rotating prism projector came up at the very beginning of motion picture films.

The two types of cameras discussed have a common feature in their mechanical design, which is that the film transport at the place of exposure is geared to the prism rotation. The development of high-speed cameras depended essentially on improvements in mechanical manufacturing and design, while the problem of optical precision was concerned only with suitable limitations for the incidence angles and with the precise thickness of the plate or prism.

The refractive index of the glass material can be shown to be without any notable influence on the quality of image formation by the rotating prism. Even the dispersion is irrelevant, due to the deliberate limitation of the incidence angle during exposure. As the Letters to the Editor in the July 1951 *Journal*

deal with these controversies in detail, there is no need to go into this aspect of the optical theory of the rotating prism.

As the choice of glass material for the prism is left free from the point of view of optical design, the final decision can be made on the basis of other considerations. With regard to the choice of the glass material, the centrifugal stress in the rotating prism is worth careful consideration. For the same angular velocity, the centrifugal force acting on the peripheral volume element is proportional to the product of the thickness of the prism and the specific gravity. The thickness of the prism must be designed proportional to:

$$\frac{n}{n-1}, \tag{1}$$

if n is the refractive index. Then the centrifugal force is proportional to:

$$\frac{n}{n-1} \cdot S, \tag{2}$$

if S is the specific gravity. For low-index glass, we may assume an ordinary crown glass with $n = 1.5$ and $S = 2.5$. A representative high-index glass may be a rare-earth glass with $n = 1.8$ and $S = 4.6$. Consequently, the product (2) is 7.5 for low-index glass, and 10.35 for high-index glass. This shows that the centrifugal force on the periphery of the high-index prism is, instead of being smaller, nearly 40% greater than on the periphery of the low-index prism.

The optical and mechanical principles underlying the construction of commercial high-speed cameras with rotating prism or plate have been known for half a century. The task of exploring the possibly hidden potentialities of the polygonal prism method, beyond the scope of conventional constructions, has long been overdue. With respect to the necessary high rate of rotation, it is of particular interest to investigate whether the mechanical properties could be essentially simplified by introducing some unconventional optical means. It would be desirable, without doubt, to avoid any gearing between prism rotation and film movement at the place of exposure. The precise position of the film relative to the prism facet could be maintained much better with a single rotating unit, serving the double purpose of mechanical and optical movement. Such a single rotating unit should incorporate the rotating prism into a film sprocket. In the conventional case, however, this is not possible, as the correctly designed polygonal prism is always larger than the corresponding sprocket, supposing equal number of frames and facets. Neglecting minor design corrections, the thickness of the prism, i.e., the distance D between opposite parallel facets, is:

$$D = \frac{HNn}{2\pi(n-1)} \tag{3}$$

in which H is the full frame height, i.e., the film length per frame; N is the number of facets; and n is the refractive index. In comparison, the diameter of the corresponding film sprocket must not be larger than:

$$\frac{HN}{\pi}. \tag{4}$$

These two formulas show that the polygonal prism could be reduced to or below the periphery of the film sprocket, but only under the condition that the refractive index is not less than 2. That means that all commercial high-index glass is useless for this purpose.

In order to arrive at a practical solution involving a single rotating unit at the place of exposure, we must abandon the idea of the solid prism as a conventional unit, which was found to require a refractive index higher than 2, if the prism has to fit within the sprocket periphery. The new polygonal prism has a composite structure. It consists of rotating and stationary components. Its rotating peripheral part is polygonal on the outside and cylindrically hollow inside. The periphery of the polygon fits into the periphery of a corresponding sprocket.

The stationary components form a separate unit, which fills the cylindrical cavity inside of the rotating polygonal ring, without obstructing the rotation. The film is guided around part of the periphery by sprocket teeth, where the exposure takes place. The curvature of the film on the periphery of the rotating component is compatible with the optical system.

The purpose of this device is to get rid of the conventional gearing in the central part of the camera, where the exposure takes place. The feed and take-up parts can remain similar to those already in use. The making of hollow polygonal prisms with twelve or more facets does not represent great manufacturing difficulties. Their use in high-speed cameras will have the advantage that for the same film speed the rate of rotation (and the centrifugal force) is slowed down in proportion to the increase of the number of facets.

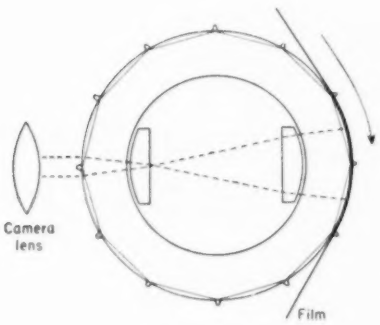


Figure 1.

Many different designs are possible, based on the principle of the composite polygonal prism. The simplest possible optical construction (Fig. 1) is shown diagrammatically in cross section through the rotation axis of the polygon, and parallel to the optical axis. In the cylindrical cavity of the rotating polygonal prism two plane-convex cylindrical lenses are placed in stationary position. The plane-parallel air gap between the flat faces of the cylindrical lenses increases the image displacement by refraction, as illustrated by two parallel rays coming from the camera lens and refracted several times. The diagram represents an air thickness between the flat sides of the two cylindrical lenses approximately equal to the total glass thickness of the composite polygonal prism, in which case the refractive index of the glass (for the polygon and the cylindrical lenses) must be about 1.6. The narrow cylindrical air menisci between the rotating polygonal component and the cylindrical lenses can be designed for zero power. (In a similar model, actually built for 35mm film, the zero power air menisci have been made 0.5 mm thick.)

It should be noted that in conventional high-speed cameras a substantial distance is kept between the film and the prism, while in the case of the new device the film under exposure is perhaps very close to the prism facets. Therefore, black shutter strips on the edges of the new polygonal prism should not be used, as they would limit the field vertically. But the required shutter effect can be achieved by suitable vertical limitations on the internal surfaces of the composite optical device.

Some important users of high-speed cameras have a particular interest in highest possible speeds. For such a purpose, it is certainly desirable to have a single rotating unit, and no gearing, in the central part of the camera.

It is in the common interest of the users and manufacturers of high-speed cameras to show clearly the inherent potentialities of the polygonal prism principle. A related development in another field is already going on. It is to be hoped that the inadequate theoretical approach, which has prevailed in this country for the last few years, will not prove a permanent obstacle in this particular field of high-speed photography.

Discussion

John H. Waddell: (an abstract of the remarks which preceded the projection of the Institute of Medical Research high-speed motion picture) Fastax prism design has been studied extensively and there are, of course, constant improvements being made in the cameras as they exist today. When one realizes that the cameras have been developed without benefit of Government sponsorship, but entirely privately, the advances which have been made have been noteworthy.

The photographic quality of the rotating prisms can be observed in the pictures which are going to be projected which were taken at the Institute of Medical Research by Dr. Myron Prinzmetal and his associates. It will be seen that the day of the rotating prism camera is not over.

Centrifugal force as discussed previously has been misinterpreted. We have never seen a prism itself explode. Failure of the prism housing has occurred however, and, in our design problems, the housing has to be constructed so that it does not fly apart when using at ultra high speeds. It is interesting to note that the camera as constructed today will take over twenty g's, and that picture taking rates far in excess of advertised rates have been successfully achieved.

Effective Sum of Multiple Echoes in Television

By A. D. FOWLER and H. N. CHRISTOPHER

Observers compared the interfering effect of multiple echoes with that of single echoes in black-and-white television pictures. The multiple echoes were 2, 4 or 8 echoes of equal strength but different delays. The single echoes were 40, 35 or 30 db weaker than the main signal. A method for estimating addition effects of several echoes is presented and demonstrated to be consistent with the test results.

THIS PAPER reports the results of tests comparing the interfering effect of multiple echoes with that of single echoes in black-and-white television pictures. The present study supplements an earlier one in which the interfering effect of single echoes was considered.[1] Although general in application, the test results have a special bearing on the design of television transmission systems, where echo requirements are rather severe and sometimes difficult to meet.

In the tests to be described, observers viewed a standard black-and-white television picture on which was superimposed, for ready comparison, either a single echo or multiple echoes. The single echo was fixed in level (a little above threshold) during a given test; the multiple echoes were then uniformly adjusted in level until they were judged to have the same interfering effect as the single echo. The multiple echoes comprised 2, 4 or 8 echoes of equal strength, and each was assigned a delay in the range of 3 to 14 μsec. The spacings, or delay differences, were uniform in a few tests and random in most.

Over 100 comparison tests, each employing eight or more observers, were made. This rather large number of tests was necessary in order to explore the effects of such things as number of echoes, levels of reference echo, weightings of echoes, spacings between echoes, poling of echoes, and types of picture material.

The results of these tests yielded an empirical relation by means of which the effective sum of multiple echoes can be estimated with reasonable precision. This relation depends upon: (a) weighted echo power; (b) number of echoes; and (c) average spacing between echoes.

Presented on April 21, 1952, at the Society's Convention at Chicago, Ill., by A. D. Fowler and H. N. Christopher, Bell Telephone Laboratories, Murray Hill, N.J.

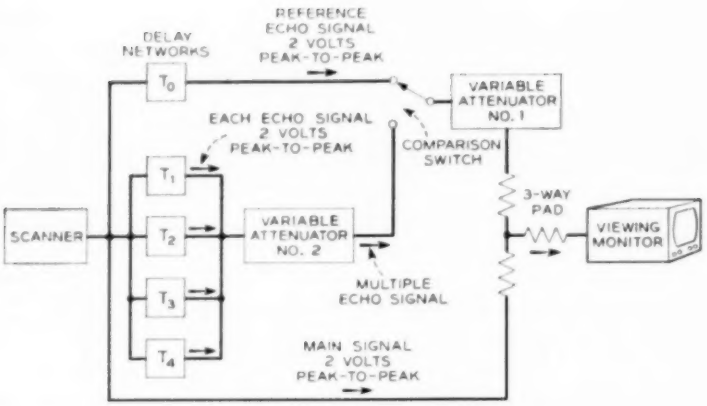


Fig. 1. Simplified schematic of test setup.

Apparatus and Circuit Arrangement

The circuit arrangement for the tests is shown schematically in Fig. 1. In this diagram, various buffing and mixing amplifiers have been omitted in the interests of simplicity. It should be understood, however, that each branch of the circuit was properly isolated and that each echo signal, apart from the indicated delay, was essentially a replica of the main signal.

Referring to Fig. 1, it will be seen that the output of the scanner, which derives composite picture signal from a slide or film, provides three signals: (a) main picture signal; (b) single reference echo signal, delayed T_0 microseconds; and (c) multiple-echo signal, comprising 2, 4 or 8 component signals (four are shown for illustration), each delayed T_1, T_2, etc., microseconds, respectively. The main signal is fed to the viewing monitor via a three-way mixing pad where echo signals are introduced. A comparison switch, operated by the observer at will, selects either single reference echo or multiple echo for transmission via attenuator No. 1 to the mixing pad. The multiple-echo path includes attenuator No. 2, by means of which an adjustable loss may be added to that path as required.

Most of the apparatus was laboratory constructed and conventional. The viewing monitor was equipped with a 10-in., black-faced, metal-backed kinescope operated at about 11 kv. The overall transmission, which otherwise would have extended somewhat higher, was limited to 4.3 mc by a phase-equalized low-pass filter.

Picture Material

Most of the tests were made with a slide called *Model White Hat*. This picture shows a close-up of a girl modeling a large white hat against a plain and rather dark gray background. It was known from previous experience that this picture was very sensitive to single echoes which were delayed by more than two microseconds.

Other slides, although known to be less sensitive to single echoes, were used in the tests. These were used because it was suspected that they might exhibit unusually severe addition effects of multiple echoes.

A motion picture film of *Model White Hat* was employed in one test. This was used to see if motion, itself, caused some of the cloudlike multiple echoes to be more readily noticed.

Procedure

A picture from the scanner was established on the viewing monitor with the proper highlight luminance and contrast ratio. Reference echo was then set at a fixed level (40, 35 or 30 db weaker than main signal) by adjustment of attenuator No. 1. The observer was then asked to view the picture with reference echo present and, upon switching alternately from reference to multiple echoes, to declare whether multiple echoes had less or more interfering effect. The experimenter would then adjust attenuator No. 2 appropriately to make the interfering effects more nearly equal. When the interfering effects were judged to be equal, the values of the attenuators were recorded, No. 1 registering the level of reference echo, and No. 2, the relative interfering effect of the multiple echoes. The test was repeated for each of the other observers.

Viewing was done in a darkened room and from a distance of four times the picture height. In two of the tests, the viewing distance was changed to 13½ times the picture height.

As a check on the results obtained by the comparison method described above, a Comment Test was made. The general procedure for this kind of test has already been reported in some detail.[2,3] A series of intermixed conditions, viz., single and multiple echoes at various levels of each, were displayed in a randomized sequence. Ten experienced observers rated each condition by choosing one of seven preworded comments listed for the purpose.

It was apparent that the relative interfering effect of single echoes of different delays would play an important part in the results. Accordingly, a comparison test was made using single echoes of various delays in the path shown in Fig. 1 for multiple echoes. The reference echo was delayed 7 μsec and was set at a level of 40 db below main signal. The same procedure and viewing conditions were employed as in the multiple-echo tests.

Summary of Results

The results of each test, together with the conditions under which the test was made, are shown in Table I. The essential test results are tabulated under the heading *Relative Interfering Effect (db)* in columns labeled *Meas.* (measured) for the appropriate level of reference echo. Entries in those columns are the average values of the settings of attenuator No. 2 for the number of observers listed. Entries in the columns labeled *Calc.* are corresponding calculated values to be discussed below.

In summarizing the results of the tests, it will be convenient to employ the terms *effective echo power*, *weighted echo power* and *advantage*. These terms are defined as follows:

Effective echo power, expressed in db above the physical power of a single reference echo, denotes the relative interfering effect as determined by subjective tests. In db, its value is given numerically by the loss in attenuator No. 2, as determined by judgments.

Weighted echo power, also expressed in db above the physical power of reference echo, is the sum of the weighted physical powers of the component echo signals. The weightings are time (delay) weightings of single echoes referred to that of the reference echo.

Advantage is the ratio, expressed in db, of *weighted echo power* to *effective echo power*. When effective echo power is less than weighted echo power, a positive advantage (over power addition) obtains; when the addition effects are more severe than power addition, a negative advantage obtains.

The principal result of these tests may be summarized in an approximate rule for estimating effective echo power of multiple echoes:

effective echo power (db) = weighted echo power (db) − advantage (db).

Table I. Test Conditions and Results.

Picture: *Model White Ike;* highlight, 42 ft-L; contrast ratio, 100:1; 24-in. (4 × *H*) viewing distance, unless noted otherwise.

No. of echoes	Delay of each echo, μsec							Ref. echo delay μsec	Avg. spacing, μsec	Wt.'d echo pwr., db	Relative interfering effect at 3 levels of ref. echo						No. of observers	Remarks
											40 db		35 db		30 db			
											Meas.	Calc.	Meas.	Calc.	Meas.	Calc.		
1	½							7			−13.8						11	
1	1							7			−7.7						11	
1	2							7			−4.9						11	Data for weighting of single echoes
1	4							7			−3.6						11	
1	7							7			0.0						11	
1	10							7			+0.6						11	
1	13¾							7			+1.2						11	
2	11	11						11	0	3.0	6.3	6.0					10	
2	11	11¼						11	¼	3.0	5.6	5.0					10	
2	10¾	11¼						11	½	3.0	4.8	4.3					10	
2	10¾	11½						11	¾	3.0	4.1	3.6					10	
2	10½	11½						11	1	3.0	3.1	3.0					10	
2	10	11½						11	1½	3.0	2.1	2.1					10	
2	10	12						11	2	3.0	2.4	1.5					10	
2	10½	11½						11½		3.0	3.5	3.0					10	
2	10	12						11½	2	3.0	1.5	1.5					10	
2	9	13						11½	4	3.0	0.6	0.4					10	
2	8¼	13¼						11½	5½	2.8	1.6	0.1					10	
2	10½	11½						11½	1	3.0	3.2	3.0	4.1	3.2	4.2	3.7	10	
2	10	12						11½	2	3.0	1.4	1.5	2.2	1.8	3.2	2.7	10	
2	9	13						11½	4	3.0	0.7	0.4	2.2	1.0	2.8	2.1	10	
2	8¼	13¾						11½	5½	2.8	0.2	0.1	1.5	0.7	2.6	1.9	10	
2	10	12						11	2	3.0	1.7	1.5	2.1	1.8	2.7	2.7	8	
2	4	4½						7	½	−0.3			0.4	1.0			8	
2	5	7						7	2	2.1			0.2	0.9			8	
2					12	13¾		7	1¾	4.3			3.5	3.4			8	
2	7				12			7	5	3.7			1.4	1.6			8	

4	3		8			$10\frac{1}{2}$		$13\frac{3}{4}$	$8\frac{1}{4}$	3.6	5.6	−0.6	+0.6	+0.3	+1.8	+3.3	+4.0	10	
4					11	12	13	14	12	1.0	6.0	6.5	6.0	6.9	6.3	7.8	7.4	5	
4					8	10	12	14	11	2.0	5.8	3.5	2.8	3.2	3.5	4.2	5.2	10	
4					6	$9\frac{1}{4}$	$11\frac{3}{4}$	$13\frac{3}{4}$	$8\frac{1}{4}$	2.6	6.2	2.2	2.1	3.5	3.1	4.7	5.0	10	
4	3	$3\frac{3}{4}$	$4\frac{1}{4}$	$5\frac{1}{2}$					$8\frac{1}{4}$	0.8	2.6	3.0	3.5	4.2	3.8	4.6	4.6	10	
4	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$					7	0.5	2.3			2.8	5.0			8	
4					5	7	12	$13\frac{3}{4}$	7	2.9	6.3			3.4	3.0			8	
4			$4\frac{1}{2}$	5		7	12		7	2.5	5.4			1.5	2.4			8	
4	3		8			$10\frac{1}{2}$		$13\frac{3}{4}$	$8\frac{1}{4}$	3.6	5.6	0.5	0.6	2.1	1.8	3.7	4.0	10	
4	3		8			$10\frac{1}{2}$		$13\frac{3}{4}$	$8\frac{1}{4}$	3.6	5.6	0.8		2.2		3.4		10	Comment test: critical (90%) observer
												1.2		2.6		3.6			median (50%) observer
8	6	8	9	10	11	12	13	14	10	1.1	8.9	9.1	8.3	8.5	8.9	8.5	10.5	10	
8	6	8	9	10	11	12	13	14	10	1.1	8.9	8.1	8.3	7.8	8.9	8.2	10.5	10	
8	3	$5\frac{3}{4}$	8	$8\frac{1}{4}$	$9\frac{3}{4}$	$10\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{3}{4}$	$8\frac{1}{4}$	1.5	8.8	5.7	6.1	6.8	7.0	7.7	9.1	23	
8	3	$5\frac{3}{4}$	8	$8\frac{1}{4}$	$9\frac{3}{4}$	$10\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{3}{4}$	$8\frac{1}{4}$	1.5	8.8	5.6	6.1	7.7	7.0	8.8	9.1	12	Motion picture
8	3	$5\frac{3}{4}$	8	$8\frac{1}{4}$*	$9\frac{3}{4}$	$10\frac{1}{2}$*	$11\frac{1}{2}$*	$13\frac{3}{4}$	$8\frac{1}{4}$	1.5	8.8	4.6	6.1	6.4	7.0	8.0	9.1	11	*Negative poling
8	3	$3\frac{1}{4}$	$4\frac{1}{4}$	$5\frac{1}{2}$	6	$9\frac{1}{4}$	$11\frac{3}{4}$	$13\frac{3}{4}$	$8\frac{1}{4}$	1.5	7.7	3.0	5.0	4.5	5.9	5.2	8.0	10	
8	3	$3\frac{1}{4}$	$5\frac{1}{4}$	$6\frac{3}{4}$	$7\frac{1}{4}$	10	$13\frac{1}{2}$	$13\frac{3}{4}$	$9\frac{1}{4}$	1.5	7.8	4.5	5.1	6.2	6.0	6.0	8.1	3	
8	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	7	12	$13\frac{1}{4}$	7	1.5	7.7			3.8	5.9			8	
8	6	$9\frac{1}{4}$	$9\frac{1}{2}$	$10\frac{1}{2}$	$11\frac{3}{4}$	$12\frac{1}{2}$	$13\frac{1}{4}$	$13\frac{3}{4}$	$9\frac{1}{2}$	1.1	9.0	9.8	8.4	10.1	9.0	10.5	10.6	10	
4					11	12	13	14	12	1.0	6.0	8.3		9.0		9.5		3	80-in. viewing distance
4					8	10	12	14	11	2.0	5.8	5.2		4.1		4.1		11	80-in. viewing distance
Picture: *Teacup Lady;* highlight, 42 ft-L; contrast ratio, 100:1; 24-in. viewing distance																			
												35 db		30 db		25 db			
8	6	8	9	10	11	12	13	14	10	1.1	8.9	11.2		12.0		12.3		3	
Picture: *Model in Patio;* highlight, 42 ft-L; contrast ratio, 100:1; 24-in. viewing distance																			
												35 db		30 db		25 db			
8	3	$5\frac{3}{4}$	8	$8\frac{1}{4}$*	$9\frac{3}{4}$	$10\frac{1}{2}$*	$11\frac{1}{2}$*	$13\frac{3}{4}$	$8\frac{1}{4}$	1.5	8.8	4.0		5.0		6.6		10	*Negative poling
Picture: *Harpist;* highlight, 40 ft-L; contrast ratio, 100:1; 24-in. viewing distance																			
												25 db		20 db		15 db			
8	3	$5\frac{3}{4}$	8	$8\frac{1}{4}$*	$9\frac{3}{4}$	$10\frac{1}{2}$*	$11\frac{1}{2}$*	$13\frac{3}{4}$	$8\frac{1}{4}$	1.5	8.8	8.4		8.2		8.3		12	*Negative poling

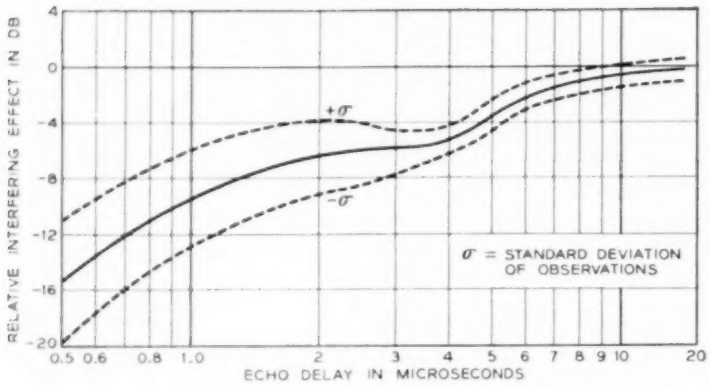


Fig. 2. Relative interfering effect of single echoes for picture *Model White Hat*. Reference echo 40 db below main signal.

Weighted echo power, for the purpose of checking the test results obtained with *Model White Hat*, can be calculated using the weighting curve given in Fig. 2. Advantage, which depends on the number of echoes and the average spacing between echoes, is given approximately by the family of curves (or straight lines) in Fig. 3. The relations shown in Fig. 3 apply when the reference echo is 40 db weaker than the main signal; at higher levels of reference echo, there is progressively less advantage. This will be seen in Figs. 4 and 5, which apply to 35- and 30-db criteria, respectively. The method of determining the empirical advantage curves from the test data is described in Appendix I.

To show how well the test results are reflected in the empirical advantage curves, the latter have been used, together with the time weightings of Fig. 2, to "predict" the test results. A comparison of the measured and computed values of effective echo power, expressed in db, is shown in Fig. 6. On the whole, the correlation is very satisfactory: 75% of the data points fall within ±1 db of the predicted values; 91% fall within ±2 db.

The picture, *Model White Hat*, chosen, as stated above, for its sensitivity to single echoes, proved to be the most sensitive of several pictures to multiple echoes. The results were substantially the same for a motion picture of *Model White Hat* as for the slide taken from the same film and used for most of the tests.

In a few tests the polarity of about half of the echoes was reversed. This produced no significant change in the results.

Increasing the viewing distance results in more severe addition effects. This is more than offset, however, by the accompanying decrease in interfering effect of either single or multiple echoes.

In a single check test, it was found that the "Comment Method" of rating picture impairments gave the same results as the comparison method used in this series of tests.

Discussion of Results

The approximate rule of addition of several echoes, as deduced from the data, is an empirical one with limited applications. It applies to eight echoes, or less, to echoes having individual interfering effects differing by no more than about 6 db, and to echo spacings

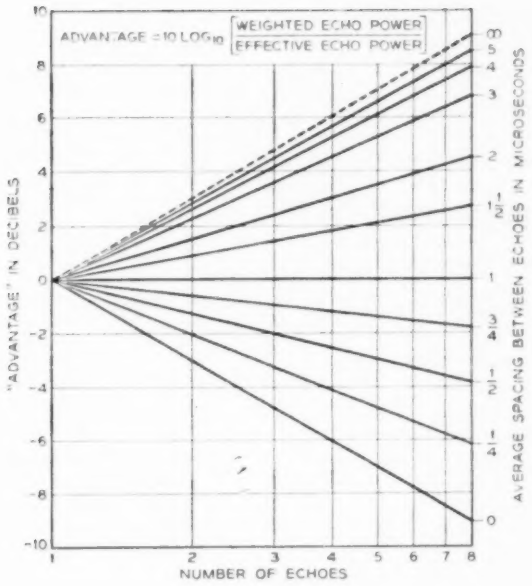

ADVANTAGE = 10 LOG10 [WEIGHTED ECHO POWER / EFFECTIVE ECHO POWER]
"ADVANTAGE" IN DECIBELS
NUMBER OF ECHOES
AVERAGE SPACING BETWEEN ECHOES IN MICROSECONDS

Fig. 3. Advantage vs. number and average spacing of echoes. Reference echo 40 db below main signal.

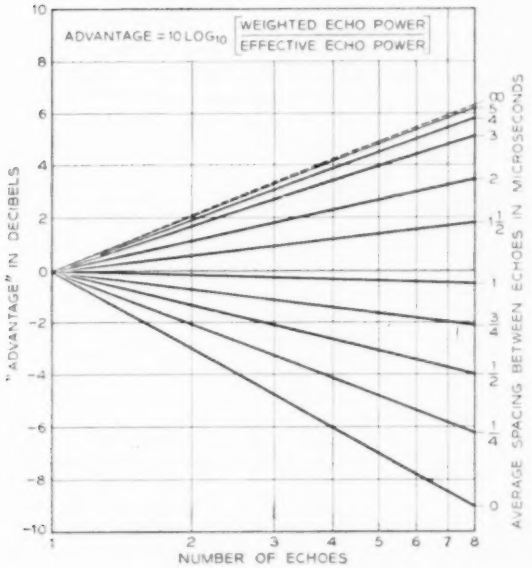

ADVANTAGE = 10 LOG10 [WEIGHTED ECHO POWER / EFFECTIVE ECHO POWER]
"ADVANTAGE" IN DECIBELS
NUMBER OF ECHOES
AVERAGE SPACING BETWEEN ECHOES IN MICROSECONDS

Fig. 4. Advantage vs. number and average spacing of echoes. Reference echo 35 db below main signal.

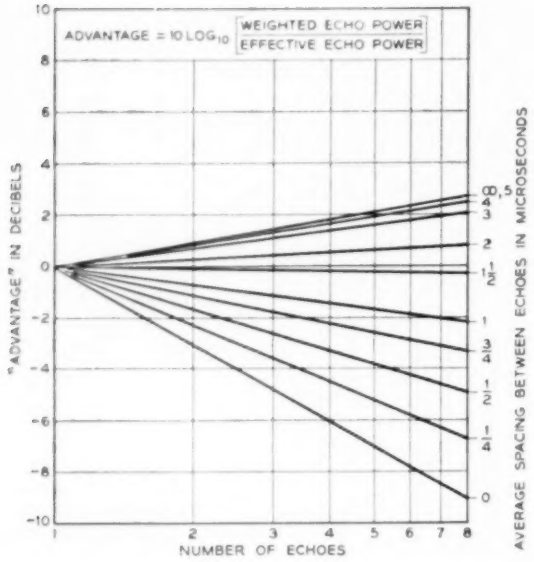


Fig. 5. Advantage vs. number and average spacing of echoes. Reference echo 30 db below main signal.

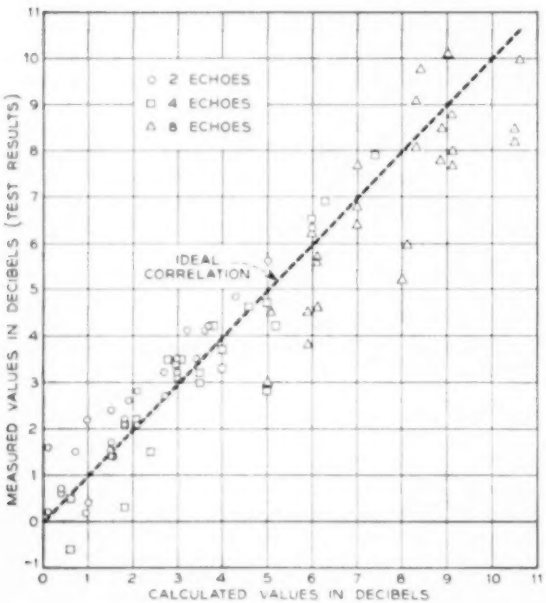


Fig. 6. Correlation of measured and calculated values of relative interfering effect. Combined data for 40, 35 and 30 db criteria.

not excessively* different from the average of those spacings. Although a general *law of addition* of echoes was not discovered, it is not clear that it would be very useful for present purposes. Such a law would probably be either very complicated, if applicable to specific cases, or too general for specific applications, if based on statistical averages.

It is generally conceded that as the number of echoes becomes large, "advantage" should tend to vanish, and the effective power of the many echoes should approach weighted power. (This presupposes a random distribution of amplitudes, polarities and delays, which tend to make the total echo signal like noise.) In this study of echo addition, there was no noticeable trend toward decreasing advantage as the number of echoes was increased (up to eight echoes) unless there was an accompanying decrease in average spacing.

In Fig. 6, showing the correlation of the test results with computed values, the data points are lumped together for the three kinds of tests where the reference echo was 40, 35 and 30 db below the main signal. Although the overall correlation is very satisfactory, a still better correlation is obtained for the 40-db data taken alone. The correlations for the 35-db and 30-db data are progressively worse. This trend is probably related to the greater difficulty observers had in comparing multiple with single echoes as the visibility of the echoes was increased.

APPENDIX I

Determination of Empirical Advantage Curves

Assume several echoes, identical in every respect except amplitude and delay. The peak-to-peak amplitudes are taken as I_1, I_2, I_3, etc., and are expressed in terms of unit amplitudes of a single reference echo. Suppose, for the moment, the delays are all rather large, so that the interfering effects of the several echoes taken singly are about the same. If all the delays are the same, the echoes will fall precisely on one another, and the effective amplitude, I_e, of the sum of the echoes will be, simply:

$$I_e = I_1 + I_2 + \ldots + I_N. \qquad (1)$$

If the delays increase progressively by about 1 μsec, the effective amplitude appears (from the test results) to be expressible as:

$$I_e^2 = I_1^2 + I_2^2 + \ldots + I_N^2. \qquad (2)$$

This suggests a simple rule of addition of the form:

$$I_e^r = I_1^r + I_2^r + \ldots + I_N^r, \qquad (3)$$

where the exponent, r, depends upon the spacing (or delay difference) of successive echoes. Although uniform spacing is assumed, moderate departures from uniformity can be tolerated.

In the tests, the physical amplitudes, I_1, I_2, etc., were equal, but in general had different time-weightings. Let the weighing of the nth echo be w_n db, where positive values of w_n mean greater interfering effect than an equal-amplitude reference echo. The interfering effect of N echoes of unit physical amplitude will exceed that of the reference echo by M db, where M is given implicitly by:

$$10^{\frac{rM}{20}} = \sum_{n=1}^{N} 10^{\frac{rw_n}{20}}, \qquad (4)$$

or explicitly by:

$$M = \frac{20}{r} \log_{10} \left(\sum_{n=1}^{N} 10^{\frac{rw_n}{20}} \right). \qquad (5)$$

The special value of M when $r = 2$, i.e., when power addition obtains, is

* The standard deviation of the spacings should not exceed the mean spacing.

designated M_0. It represents *weighted echo power*, expressed in db above the power of reference echo, and is given by

$$M_0 = 10 \log_{10} \left(\sum_{n=1}^{N} 10^{\frac{w_n}{10}} \right). \quad (6)$$

When the weightings are small — and they were purposely made so by making the delay of the reference echo about equal to the mean delay of the N echoes — first-order approximations can be used with fair accuracy in computing (5) and (6). Approximately, then,

$$M \doteq \frac{20}{r} \log_{10} N + \frac{1}{N} \sum_{1}^{N} w_n, \quad (7)$$

and

$$M_0 \doteq 10 \log_{10} N + \frac{1}{N} \sum_{1}^{N} w_n. \quad (8)$$

The difference, $M_0 - M$, is defined as *advantage* and is designated by A, where

$$A \doteq \left(1 - \frac{2}{r}\right) 10 \log_{10} N. \quad (9)$$

Note that when $r = 2$, $A = 0$ for power addition; when $r = 1$ (zero spacing between echoes), $A = -10 \log_{10} N$, indicating current (or voltage) addition; and as $r \to \infty$, $A \to +10 \log_{10} N$, indicating no addition effects, i.e., M is determined by the single most effective echo of the group.

The approximate expression, (9), for *advantage*, depending only on spacing (as r does) and number of echoes, N, was used as the basis for processing the data. The test data gave values of M directly; M_0 (relative weighted echo power) was computed using the weighting curve of Fig. 2; subtracting M from M_0 gives *advantage*, A. Dividing A by $10 \log_{10} N$ gives the factor $(1 - 2/r)$. At this point the data are segregated according to criterion, i.e., reference echo at 40, 35 and 30 db below main signal. The factor $(1 - 2/r)$ was then plotted separately for each criterion and, in all cases, against ΔT, the average spacing of echoes. The relations, $(1 - 2/r)$ vs. ΔT could fairly accurately be represented by smooth curves. By choosing ΔT as parameter, and using values of $(1 - 2/r)$ taken from the smooth curves, expression (9) can be plotted in the form shown in Figs. 3, 4 and 5.

In each of the above three figures, one of the *advantage* curves is indicated for $\Delta T = \infty$. These represent the apparent limits of positive *advantage* approached as ΔT is increased somewhat beyond 5 or 6 μsec. The limiting values of *advantage* were derived from the smooth curves of the factor, $(1 - 2/r)$, which appeared to have asymptotic values as ΔT increased.

References

1. P. Mertz, A. D. Fowler and H. N. Christopher, "Quality rating of television images," *Proc. IRE, 38:* 1269–1283, Nov. 1950.
2. A. D. Fowler, "Observer reaction to low-frequency interference in television pictures," *Proc. IRE, 39:* 1332–1336, Oct. 1951.
3. A. D. Fowler, "Observer reaction to video crosstalk," *Jour. SMPTE, 57:* 416–424, Nov. 1951.

ABSTRACT

The Image Iconoscope— a Camera Tube for Television

By P. SCHAGEN, H. BRUINING and J. C. FRANCKEN

The oldest television camera tube, the iconoscope, is now used only for transmitting still pictures (e.g. the signal picture of a certain station) and film pictures. Further development of camera tubes in Europe has followed a course different from that in America. In the U.S.A. the image orthicon has become predominant, whilst in Europe the image iconoscope is widely used. Of the latter there are British and French versions and also one that has been developed in the Philips Laboratory at Eindhoven (Netherlands). This Philips image iconoscope is described here and compared with other camera tubes.

THE OBJECT of television is to transmit moving pictures via electrical means. This is achieved by "measuring" in succession the brightness of the very large number of picture elements into which the picture to be transmitted is imagined as being divided. This measuring consists in the conversion of the brightnesses into corresponding fluctuations of an electric current which in some way or other govern the signal transmitted.

However the time available for measuring the brightness of one picture element is very small, actually only 10^{-7} sec. A method can be imagined, whereby the imaged scene is illuminated continuously on a photosensitive plate, while for each picture element in succession in the space of time of 10^{-7} sec a signal is transmitted which corresponds to an illumination that was present during the whole of the time ($\frac{1}{25}$ sec) available per picture. This idea is to be found materialized in all present-day television camera tubes. With this method there is a continuous accumulation of charge during a frame period, and thus these tubes have come to be known as "storage tubes."

The oldest form of storage tube is the iconoscope, designed by Zworykin (1933). In the main this article will be devoted to a modern camera tube named the image iconoscope. Some other types will be mentioned in passing.

Classification of Modern Camera Tubes

In the most important camera tubes of modern design there is a plate ("target" or "mosaic") on which is projected an electrical image consisting of a two-dimensional pattern of electric

Abstract by Pierre Mertz of a paper in *Philips Technical Review, 13:* 119–133, Nov. 1951.

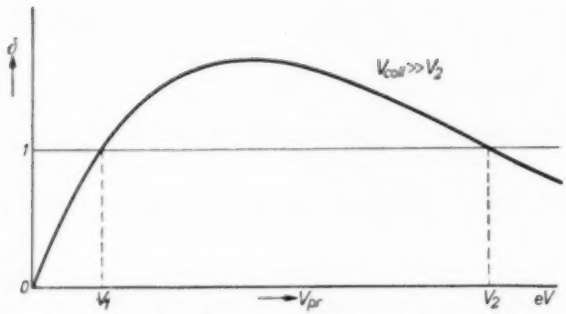


Fig. A. Secondary-emission coefficient δ of an insulator, as a function of the energy V_{pr} of the primary electrons. At two values of V_{pr} (V_1 and V_2) δ is equal to 1. This curve applies when the collector potential is high compared with V_3.

potentials corresponding in amplitude and position to the luminance in the optical image of the scene to be transmitted. This electrical image is scanned point by point by a focused beam of electrons (the scanning beam), the potentials being thereby reduced to a certain "stabilizing potential" which in some way or other produces an electric signal.

The target is, of course, made of an insulating material, e.g. mica. When an electron beam is directed upon it the rule is that for every surface element, in the stable state, on an average just as many electrons have to be emitted as impinge upon it.

When the primary electrons impinge upon a surface element of the plate they release secondary electrons from the material. The secondary-emission coefficient δ, i.e. the average number of secondary electrons released by one primary electron, depends upon the material and the velocity (thus the energy) of the primary electrons at the plate. If V_{coll} is so high that the collector attracts all the secondary electrons towards it, then the variation of δ as a function of the energy V_{pr} (expressed in electron-volts) of the primary electrons is as represented in Fig. A. In the case of most materials there are two values for V_{pr} where $\delta = 1$; the smaller of the two is denoted by V_1, the larger by V_2. For mica, for instance, these material constants are in the order of 10 volts and some thousands of volts, respectively.

Upon reducing V_{coll}, the potential of the surface will be stabilized at a value V_3, where the current intensity of the secondary electrons actually reaching the collector (i_{coll}) is equal to the current intensity i_{pr} of the primary beam. As a rule V_3 is slightly higher than V_{coll} (Fig. B); in contrast with V_1 and V_2, V_3 is therefore not a material constant.

Thus, when bombarded with slow electrons ($V_{pr} < V_1$) the surface potential becomes stabilized at zero, and when bombarded with electrons of high velocity it becomes stabilized at the value V_2 (provided $V_{coll} > V_2$) or at V_3 ($\approx V_{coll} < V_2$). For the target of a camera tube however no use is made of the value V_2, for practical reasons; it is strongly influenced by the condition of the surface and thus is too variable from point to point.

It is according to these possibilities that camera tubes are classified as:

(1) low velocity tubes, where the target is stabilized at cathode potential, and

(2) high velocity tubes, where the target is stabilized at the potential $V_3 \approx V_{coll}$ (e.g. 1000 v).

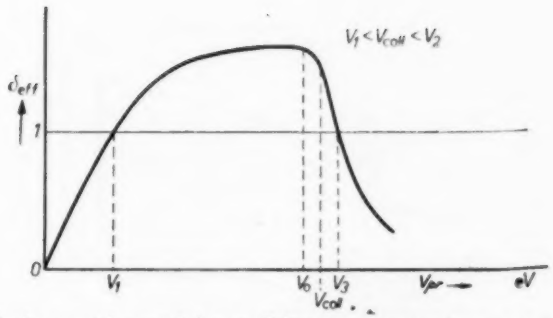


Fig. B. Effective secondary-emission coefficient δ_{eff} of an insulator, as a function of the energy V_{pr} of the primary electrons when the collector potential V_{coll} is smaller than V_2 (cf. Fig. A). $\delta_{eff} = 1$ at $V_{pr} = V_1$ and at $V_{pr} = V_3$, the latter value being a few volts higher than V_{coll}. To the left of V_0 (slightly lower than V_{coll}) the curve is identical to that in Fig. A.

Among the first belongs the image orthicon, which is the type of tube mainly used in the U.S.A., while belonging to the second group are the iconoscope and the image iconoscope, the latter often being given preference in European television circles. One of the reasons for this preference is related to the large number of lines adopted on the West-European continent (625, and in France 819): with a high electron velocity it is easier to satisfy the high requirements for the focusing of the scanning beam which are demanded for the definition required for such a large number of lines.

The Iconoscope

The iconoscope is the camera tube which in its time gave such an impetus to television.[1] It is schematically represented in Fig. C, while in Fig. D a photograph is given of the Philips iconoscope, type 5852.

A lens (objective) projects an image of the scene onto a target of thin mica coated on the front with a mosaic of minute, mutually insulated, photosensitive elements. On the reverse side is a coating of metal, called the signal plate, forming the output electrode and externally connected to earth via a resistor. A ring-shaped coating of metal on the inside of the envelope serves as collector and is connected to earth direct.

The action of the iconoscope is sometimes explained in the following (inadequate) way. The incident light causes the photoelectric elements of the mosaic to emit photoelectrons, which are taken up by the collector. Thus a positive electrical image is formed on the mosaic. The photoelectric elements together with the target form as many minute capacitors. As the scanning beam moves across the mosaic the group of capacitors belonging to a certain picture element are discharged. Through the resistor via which the signal plate is earthed there then flows a small current corresponding in intensity to the charge of the picture element, thus corresponding to the local luminance of the optical picture. Thus in the scanning of the electrical image a series of current impulses are generated which together form the video current.

Actually the position is not so simple as this. Such a description does not take into account the part played by

[1] See, e.g., *Philips Tech. Rev.*, *1*: 18–19, 1936.

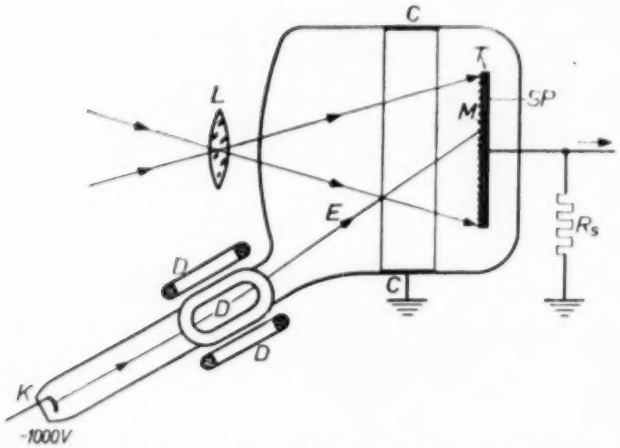


Fig. C. Iconoscope. *L*, a lens projecting the scene on the mosaic *M* of the target *T*. *SP*, signal plate; R_s, load resistor; *C*, collector; *K*, cathode; *D*, deflection coils; *E*, scanning beam. The (electrostatic) focusing is not shown.

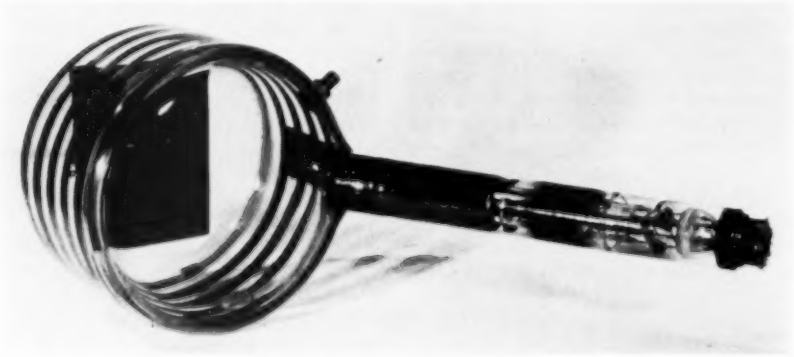


Fig. D. The Philips Iconoscope, Type 5852.

secondary emission.[2] Not all the secondary electrons reach the collector, firstly because the potential of a bombarded surface element is higher than $V_{coll.}$ The secondary electrons which do not reach the collector fall back on other parts of the mosaic. This distribution of the secondary electrons is called the redistribution effect, and it is of essential importance for the action of the iconoscope.

After the surface element in question has been scanned, it will continue to receive secondary electrons originating from other surface elements, until it is scanned by the beam again. Thus its potential *V* begins to drop (Fig. E).

During a considerable part of the

[2] V. K. Zworykin, G. A. Morton and L. F. Flory, *Proc. I.R.E.*, *25*: 1071–1092, 1937; and W. Heimann and K. Wembeuer, *Z. tech. Phys.*, *19*: 451–454, 1938.

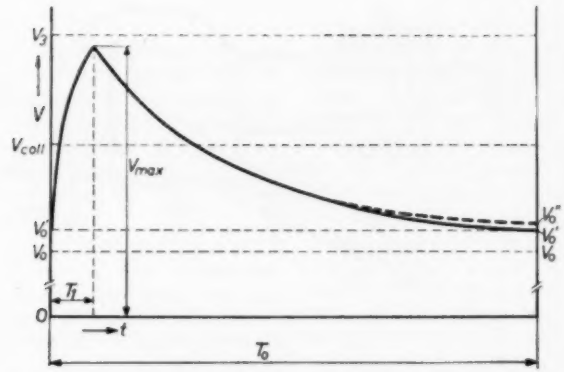


Fig. E. Curve of the potential V of a picture element on the mosaic of an iconoscope, as a function of the time t. Fully drawn line: mosaic not illuminated; broken line: mosaic illuminated. T_0 = scanning period for the whole image (0.04 sec), T_1 = scanning time for one picture element (10^{-7} sec; in the drawing highly exaggerated). For the meaning of V_{coll} and V_3 see Fig. B, and for V_0, V_0', and V_0'' see the text.

scanning period the potential V of the element is higher than V_{coll}, and the photoelectrons do not possess sufficient energy to overcome this potential difference. Photoemission begins, therefore, when — owing to the redistribution effect — the potential V has been sufficiently reduced.

The most important features of the iconoscope will now be briefly discussed.

As already explained, it is due to the redistribution effect that photoemission can take place, but this is only possible during a fraction of a scanning period. Thus we are still far removed from a continuous photoemission such as was imagined in the case of an ideal storage tube! This is one of the reasons for the iconoscope's rather low sensitivity.

A second cause of the lack of sensitivity lies in the mosaic form of the light-sensitive layer. The insulation between the elements does not contribute towards photoemission, so that a considerable part of the surface of the target is photoelectrically inactive.

The main cause of spurious signals (see the literature quoted in footnote [3]) is that the redistribution does not take place in the same way all over the mosaic, owing to the surroundings of the elements not being the same everywhere.

When the iconoscope is illuminated the spurious signal is superposed on the picture signal and only if the latter is of a reasonable strength is the spurious signal not very disturbing. It is for this reason that with the iconoscope very high intensities of illumination are needed.

The stronger the illumination on a certain part of the mosaic, the higher is the potential V_0'' at that spot just before it is scanned by the beam. This has two consequences: there is slightly less chance of further photoelectrons escaping, and there is a somewhat greater attraction of redistributed secondary electrons. Both these effects result in the amplitude of the signal increasing less than proportionately with the illumination. This nonlinearity is rather an advantage than a disadvantage in that it compensates fairly well an inverse nonlinearity between the beam current and the control voltage in the picture tube of the receiver. Thus there is no need to take steps to compensate the latter nonlinear effect.

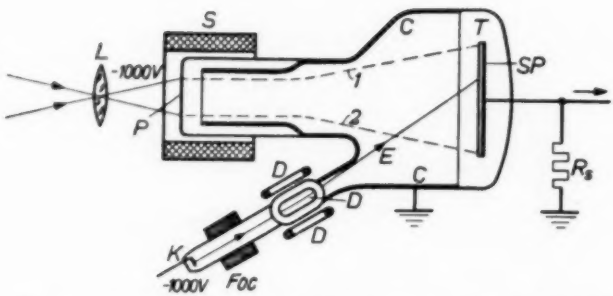


Fig. F. Image iconoscope. *P*, photocathode; *S*, coil of the magnetic electron lens; *1* and *2*, paths of photoelectrons; *FOC*, focusing coil. Other letters have the same meaning as in Fig. C.

Fig. G. The Philips Image Iconoscope, Type 5854.

The Image Iconoscope

The greatest disadvantage of the iconoscope is its lack of sensitivity, and it is for that reason that attempts have been made to develop camera tubes with greater sensitivity, while still retaining the good picture quality obtained with the iconoscope when the scene is sufficiently illuminated.

A year or two prior to 1940 a more sensitive version of the iconoscope, called the image iconoscope, was developed in the U.K. and in the U.S.A.[3] Some improvements on this have since been made in the Philips Laboratory at Eindhoven, as will appear in the course of this article.

In the case of the image iconoscope (Fig. F) a lens (objective) projects an optical image of the scene to be televised onto a continuous, transparent photocathode. The local density of emission of the photoelectrons corresponds to the local luminance of the optical image. This photoemission image is focused by an electron lens onto a target consisting in this case of a thin layer of insulating material applied to the signal plate. The metallized inner wall of the envelope serves as collector. An electron gun mounted in an arm of the envelope supplies the beam of electrons scanning the target.

The differences, compared with the conventional iconoscope, which are mainly responsible for the gain in sensitivity, are the following:

(1) The surface of the photocathode is continuous, so that none of its effective area is lost in insulation between the separate photoelectric elements.

(2) The stream of photoelectrons reaching the target is reinforced by secondary emission, each photoelectron releasing on an average more than two secondary electrons.

(3) The secondary electrons released from the target by the photoelectrons have a much greater energy than the photoelectrons in the ordinary iconoscope, so that secondary emission from a surface element begins immediately after that element has been stabilized by the scanning beam. This means a considerable gain in storage action.

Let us now consider more closely the principal parts of the image iconoscope and also the important question of electron-optical projection. The Philips type of image iconoscope is illustrated in Fig. G.

Contrary to ordinary photoelectric cells, an image iconoscope must have a photocathode which is semitransparent, because the light enters from the outside while the photoelectrons have to emerge on the inside.

The requirements greatly restrict the choice of photoelectric material to be used. The photocathode in the Philips image iconoscope consists of a very thin coating of cesium, antimony and oxygen applied to a flat part of the glass envelope. The sensitivity for the light from an incandescent lamp with color temperature 2600 K is about 45 μa per lumen. The spectral sensitivity curve, compared with the relative luminosity curve for the normal eye, is slightly displaced towards the blue (Fig. H).

The optical image of the scene is converted into a corresponding photoemission image on the photocathode. The next step is to produce on the target an electrical image which is a faithful replica of the photoemission image. This requires that the small beams of photoelectrons emitted from points of the photocathode are focused on corresponding points on the target. For this electron-optical image formation an electron lens is needed.

An electric field has to be employed. This is obtained by means of a metal cylinder (e.g. the metal coating A on the inner wall of a glass tube, Fig. I) facing the photocathode P and applying a potential difference of, say, 1000 v

[3] See, e.g., H. Iams, G. A. Morton and V. K. Zworykin, "The image iconoscope," *Proc. I.R.E.*, *27:* 541–547, 1939.

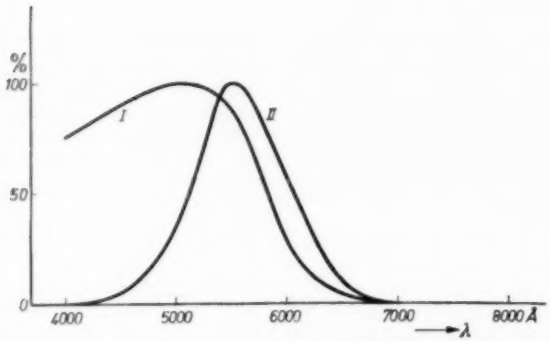


Fig. H. Relative spectral sensitivity of the Type 5854 image iconoscope (curve *I*), compared with the relative luminosity (curve *II*), as functions of the wavelength λ of the light.

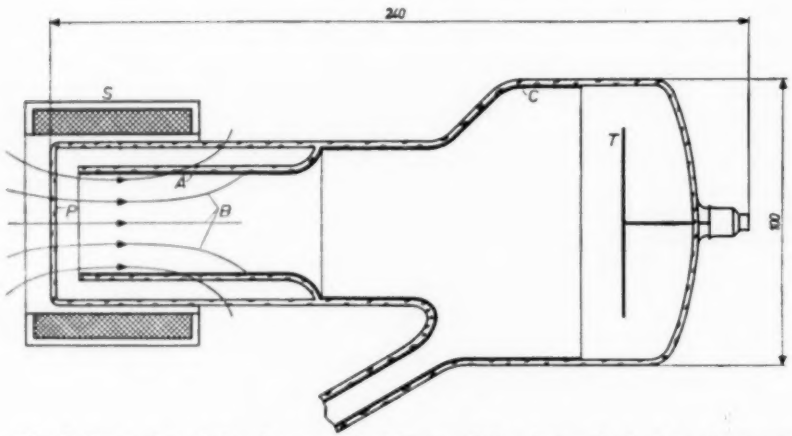


Fig. I. Formation of the electron-optical image of the photocathode *P* on the target *T* with the aid of an electric field (between *P* and the cylinder *A*) and a magnetic field. The latter (lines of flux density *B*) is produced by a focusing coil *S*. Dimensions are in millimeters.

between these electrodes. Since the cylinder forms, electrically, one whole with the earthed collector, the photocathode is given a potential of −1000 v with respect to earth.

This electric field alone, however, does not suffice; a magnetic field has to be added which focuses each electron pencil. Such a field can be produced by means of a coil placed concentrically around the tube. The coil has to be of such dimensions and in such a position as to minimize aberrations, whilst the magnetic field must not disturb the movement of the scanning beam.

The movement of the electrons depends not only upon the two fields mentioned but also upon the velocities of the electrons leaving the photocathode. Some of them have zero initial

velocity, and the paths they follow are called the principal rays. Generally, however, the electrons leave the cathode with a certain velocity, with the result that they follow a more complex path.

Briefly, the course of a principal ray is as follows: at first the path is approximately parallel to the axis of the tube (the z axis), then it diverges farther and farther from that axis, turning about the z axis first clockwise and later counterclockwise in the form of a widening helix.

Although most of the electrons which leave the photocathode have velocities greater than zero and thus do not follow any principal paths, still it is the principal rays which determine the geometry of the electron-optical image. Each forms the axis of a small electron pencil.

The axial component of initial velocity gives rise to a certain "chromatic" aberration: a point of the photocathode from which electrons emerge with axial velocity does not result in a point being formed on the target but a small circle (scattering circle), the diameter of which is so small — thus the image so sharp — that the image iconoscope can quite well be worked with more than 600 scanning lines. In the image orthicon, on the other hand, the electric field at the cathode is ten times smaller,[4] so that with this type of tube the formation of the electron-optical image is a limiting factor for the number of lines.

Owing to the predominance of the diverging forces acting upon the electrons following the principal path the image on the target is magnified, and owing to the tangential forces the electron image is rotated with respect to the optical image on the photocathode, the angle of rotation being about 30 to 40°.

With our image iconoscope the magnification is normally 3.75, which means to say that the scanned part of the target, which always covers an area of 45 mm × 60 mm, corresponds to an area of 12 mm × 16 mm on the photocathode (the diameter of the active part of the photocathode is 20 mm). By exchanging the coil for another of different dimensions it is also possible, however, to work with a larger or a smaller magnification, thus projecting a smaller or a larger part of the photocathode on the target. The choice as regards the size of the effective photocathode is governed by requirements of an optical, light-technical and camera-technical nature. The limits for the magnification are 2.75 and 7.5 (diameter of the projected part of the cathode, respectively, 27 mm and 10 mm).

With a magnification greater than 7 to 8, owing to the "chromatic" aberration of the photoelectrons emerging with axial velocity (see above) there is too great a loss in resolving power.

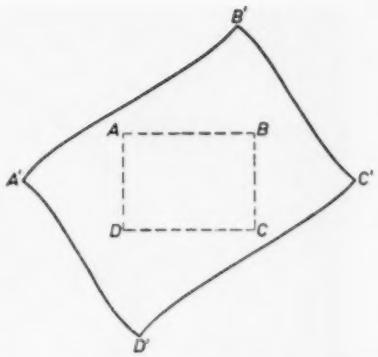


Fig. J. $ABCD$ is an image on the photocathode, $A'B'C'D'$, the corresponding electrical image on the target. The latter is magnified and turned with respect to $ABCD$ and also shows some S distortion, which always occurs when magnetic lenses are used (straight lines are projected with a slightly S-shaped curve). If the magnification is too small the S distortion becomes so pronounced that it can no longer be sufficiently corrected.

H. B. De Vore, *Proc. I.R.E.*, *36*: 335–345, 1948.

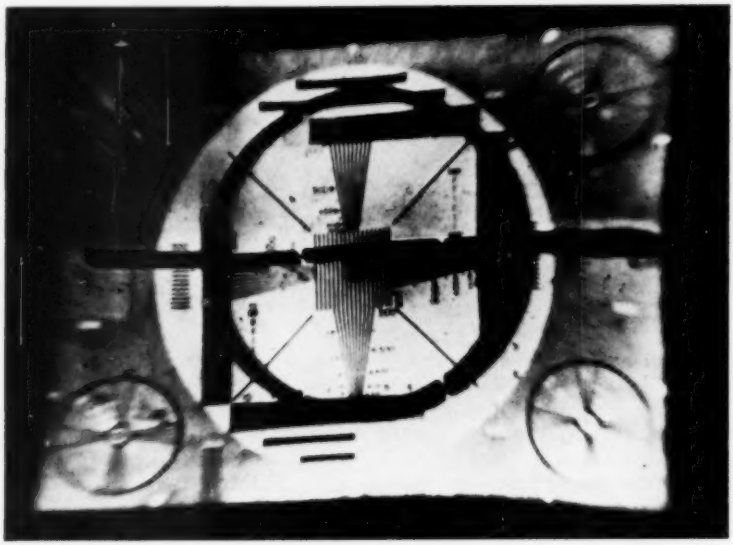


Fig. K(1). Picture showing a marked field curvature, pin-cushion distortion and S distortion. In Fig. K(2), there is only a slight S distortion, which can easily be corrected electrically.

These photographs have been taken with the aid of an experimental tube in which a fluorescent screen was used instead of a target. On the photocathode a test pattern was projected, as used in television, for detecting aberrations and checking the definition and gradation. The heavy black circle and the thick horizontal line in the middle correspond to markings on the photocathode for determining the magnification.

The lower limit of 2.75 is due to various other aberrations, which with a smaller magnification can no longer be sufficiently compensated. As such may be distinguished: field curvature, pin-cushion distortion and so-called S distortion. The first two are known from light-optics.[5] By S distortion is meant the effect of the image of a straight line being projected as a line curved somewhat in the shape of the letter S (Fig. J). If the magnification is not too small the S distortion can be sufficiently corrected by electrical means (which we cannot enter into here), but if it is less than 2.75 this is no longer possible. In Fig. K(1) a picture is given showing all three aberrations to a marked extent. The picture in Fig. K(2), however, has only a scarcely perceptible S distortion, which is not troublesome.

The electron gun supplies the scanning beam. Just as is the case with most picture tubes, in the image iconoscope the beam is focused and deflected with the aid of magnetic fields.

In regard to the sharpness of the scanning, there are two things to be considered. The non-deflected beam is focused on the center of the target, where its diameter must be so small that the lines do not overlap when being scanned. If it is desired to work for instance with 1000 lines then, if the height of the scanned part of the target

[5] A review of various optical aberrations is to be found, for instance, in: W. de Groot, *Philips Tech. Rev., 9:* 301–308, 1947, in particular pp. 304 and 306.

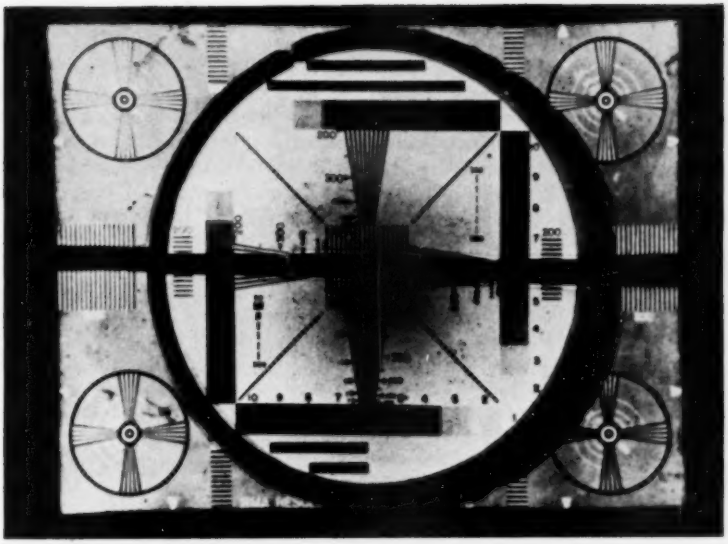


Figure K(2).

is 45 mm, the effective diameter of the focus must not be more than 45μ. This requirement is all the better fulfilled the higher the acceleration voltage is chosen, but this should preferably not exceed 1000 v.

Further, account has to be taken of the fact that in the image iconoscope the electron gun has to be mounted with its axis at an angle to the target. Consequently when the beam is deflected upward or downward the focus is no longer situated on the target. Therefore, to obtain sufficiently sharp scanning also away from the center, the beam must have a good depth of focus, which means that it has to be extremely narrow. Hence the angle of divergence $2a_t$ (see Fig. L) has to be kept very small.

It is, in general, difficult to obtain a fine focus with a very narrow beam on account of the mutual repulsion of the electrons, but fortunately the intensity of the beam current required is very low, in the order of 0.1 μa.

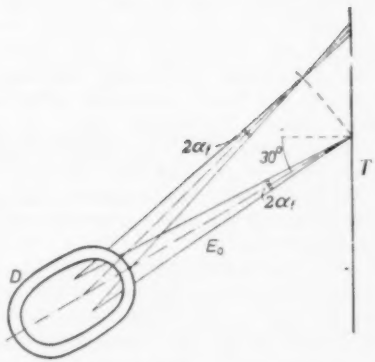


Fig. L. Assuming that the nondeflected beam E_0 has been focused onto the center of the target T, when the beam is deflected the focus will no longer be in the plane of T. This gives rise to blurring, the extent of which increases with the angle of divergence $2a_t$.

In addition to this space-charge repulsion there is another factor limiting the spot size obtained with a very narrow beam: there is a very fundamental relationship between the angle of divergence $2a_f$ and the current density in the beam. In the case where the space charge is negligible this relationship is:

$$\sin^2 a_f = \frac{V_0}{V} \cdot \frac{j_f}{j_0}, \quad \ldots \quad (1)$$

where $V_0 = \frac{1}{2}mv_0^2/e$ (with m = mass, v_0 = initial velocity and e = charge of an electron), V = the potential difference traversed by the electrons, j_f = density of the beam current in the focus, and j_0 that at the cathode of the gun.

What has to be found is an optimum value for a_f at which, on the one hand, the focus is not too large and, on the other hand, the sharpness at the edges of the image does not differ too much from that in the middle. With our image iconoscope the position is such that this optimum value of a_f lies at about 3×10^{-3} radians.

This small angle of divergence, combined with a low beam current intensity (about 0.2 μa), has been obtained by placing two diaphragms in the beam. The first, with a narrow aperture, confines the beam within the desired small angle. The second one, with a wider aperture, allows the beam to pass through without hindrance but intercepts the low-velocity secondary electrons formed round the edge of the first diaphragm.

With the focus of 45 μ already mentioned and a beam current of 0.2 μa, the average current density in the focus is j_f = 12 ma/sq cm. Substituting this in Eq. (1), and for V the value 1000 v, and for V_0 the value corresponding to the average initial velocity ($\approx$ 0.1 v), we find for the average current density at the cathode of the gun $j_0 \approx 120$ ma/sq cm. The peak value of the current density is in fact several times greater. Although an ordinary oxide-coated cathode may indeed be continuously loaded with such a current density, it is better to use what is known as an L cathode,[6] since this has a much longer life. It would be quite undesirable if the useful life of a costly tube such as the image iconoscope were to be dependent upon the life of a component like the cathode of the gun.

The glass arm of the envelope containing the electron gun has been kept as narrow as possible (internal diameter 11 mm, external 14 mm), so that also the focusing coil and the deflection coils may be small. A camera with an image iconoscope is shown in Fig. M.

In practical use the resolving power of the Philips image iconoscope is found to be 900 to 1000 lines in the middle of the image and about 700 lines at the edges. (These limits are set by the electron gun; the resolving power of the electron-optical projection is very much greater.)

An improvement has been reached by coating the mica target with a thin layer of MgO, which leads to a considerable gain in secondary emission and hence sensitivity. Furthermore, owing to the coating of MgO, stains on the mica which cannot be removed and otherwise show up clearly in the picture are thereby made invisible.

The capacitance of a surface element of the target with respect to the signal plate is an important factor, and an increase of this capacitance must lead to greater sensitivity.

New tubes were therefore made with a mica sheet of only about 25 μ thickness (also with a layer of MgO, thin compared with the mica) instead of the original sheet thickness of 50 μ.

The reproduced picture of a scene televised under the normal studio lighting, or of an outdoor scene in daylight

[6] H. J. Lemmens, M. J. Jansen and R. Loosjes, "A new thermionic cathode for heavy loads," *Philips Tech. Rev.*, *11:* 341–350, 1950.

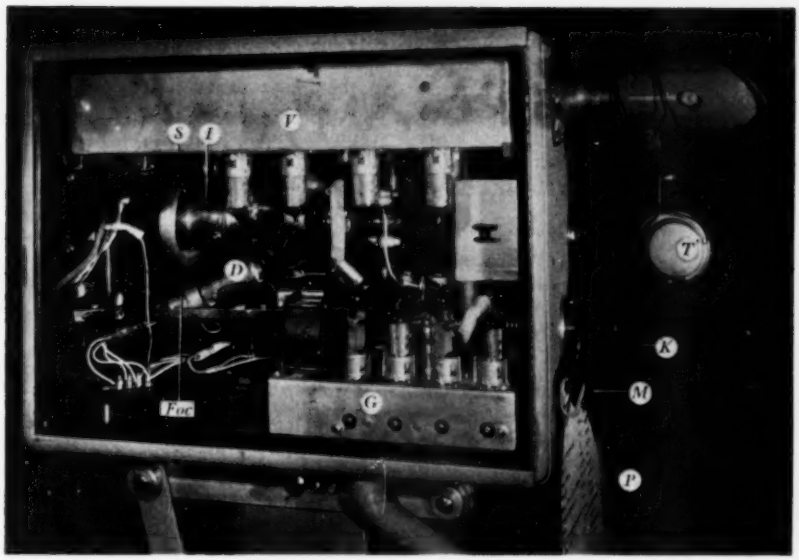


Fig. M. One of the cameras used for the experimental television broadcasts at Eindhoven. One side panel and a screen have been removed. *I*, image iconoscope Type 5854; *S*, image coil; *FOC*, focusing coil; *D*, deflection coils; *G*, time-base generator; *V*, chassis with monitor picture tube and accessories; *M*, microphone and *T*, telephone for communication between the operater and the control room; *K*, knob for exchanging the objective; *P*, playbook.

(even in bad weather), with the image iconoscope last described, is almost free of "noise" and shows excellent gradation.

In the image iconoscope spurious signals arise from the same cause as in the case of the conventional iconoscope: the various surface elements of the target are not all in the same position with respect to the scanning beam. In the image iconoscope, however, the situation is more favorable: with the tube described (mica 25 μ thick, beam current 0.2 μa) and with an illumination producing a photocurrent of more than 0.1 μa, the spurious signals are so weak that there is hardly any need of compensating measures. In practice a photocurrent of 0.1 μa can be obtained with an illumination of the scene of about 1000 lux, when using a non-diaphragmed, normal objective with aperture $f/2$.

Comparison of Different Types of Camera Tubes

Let us now compare, briefly, the two main types of camera tubes, the high-velocity and the low-velocity types.

In the first place there is the question of sensitivity. This resolves itself into two factors (disregarding the efficiency of the optical system), viz. the sensitivity of the photocathode (photocurrent I_{ph} in relation to the light flux falling on the cathode) and the sensitivity of the scanning mechanism (ratio of signal current I_s to photocurrent I_{ph}).

As regards the sensitivity of the photocathode of the two high-velocity tubes — the conventional iconoscope and the

image iconoscope — the latter has very much the advantage, owing to the continuity of the photocathode. Among the low-velocity tubes there are likewise types with a mosaic cathode and others with a continuous cathode, the latter including the image orthicon, which as regards photocathode sensitivity is equal to the image iconoscope.

The scanning sensitivity of low-velocity tubes is simply 1 μa signal current per μa photocurrent. In high-velocity tubes the phenomenon of redistribution complicates matters, but the scanning sensitivity of the ordinary iconoscope can be put at $\frac{1}{20}$ μa/μa and that of the image iconoscope, at about 1 μa/μa.

Although, therefore, the image iconoscope has about the same scanning sensitivity as the simple low-velocity tube, the $I_s = f(I_{ph})$ curve is not linear, whereas in the case of low-velocity tubes it is linear; the nonlinear curve is favorable, as explained when dealing with the iconoscope.

There is a means, however, of appreciably increasing the scanning sensitivity of low-velocity tubes. The electrons from the scanning beam which are not taken up by the target and return to the gun can be collected in a multiplier, placed around the gun, which works with secondary emission and thus multiplies them. This is what takes place in the image orthicon, commonly employed in the U.S.A. In this way the scanning sensitivity may be raised to a value of 25 to 100 μa/μa, which is of course valuable when scenes have to be televised in poor light. However, the current of the returning beam can be modulated only up to about 20% and consequently contains a relatively large amount of noise.

It has already been explained that in regard to spurious signals the image iconoscope has a decided advantage over the ordinary iconoscope. The image orthicon is free of spurious signals of this nature, but on the other hand it is subject to another interference connected with the fact that the secondary-emitting surfaces of the multiplier do not have exactly the same secondary-emission coefficient over the whole area ("dynode spots").

Electron-optically, high-velocity tubes have undeniably the advantage over those of the other group, in that with electrons of a high velocity it is easier to obtain a scanning beam with a high resolving power, and there is much less trouble from interfering electric and magnetic fields.

TelePrompter — New Production Tool

By FRED BARTON and H. J. SCHLAFLY

The TelePrompter is a device now being used extensively in motion picture and television productions, and by public speakers as an aid in delivery of a prepared script. It is a production tool of great flexibility; its technical features and applications are described.

THE PROBLEM of presenting entertainment to the public has been accentuated by the very nature of the television industry because of its continual requirement for new material. Whether this material is "live," that is, performed directly in front of television cameras or filmed before it is translated into a television signal, the continual demand for new material of an expected quality presents many pressing problems. One of these problems is the fundamental necessity of memorization. Added to the tension that normally accompanies the production of a television or motion picture presentation is the very real and continuing chore of memorization of lines for the actor, and the constant threat of fluffs, delays and retakes for the producer. A professional performer accepts, as part of his vocation, the necessity of studying his lines. Such a professional can substantially memorize new material with comparatively few readings, but in order to reach the point of perfection, the point which makes the difference between a smooth and a ragged performance, this same performer may spend many tedious hours of study. Those who are not normally engaged in the entertainment or public-speaking professions find this problem of memory so much the more difficult. The necessity for accurate memorization breeds a second evil which may be even more devastating to a good performance than the mere fault of forgetting the line. This second evil is the *fear* of forgetting the lines and the resulting tension, tightness and unnaturalness unconsciously generated by such fear.

The TelePrompter is a modern approach to the old problem of prompting. It is a new production tool whose intelligent use can save hours of rehearsal, help to promote a smooth and relaxed performance, and reduce film studio retakes. Not only does its use result in the 100% perfect script without hours of laborious work and mental exercise, but it serves also as a guardian against fear. Paradoxically its mere presence

Presented on April 21, 1952, at the Society's Convention at Chicago, by Fred Barton and H. J. Schlafly, TelePrompter Corp., 270 Park Ave., New York 17, N. Y.

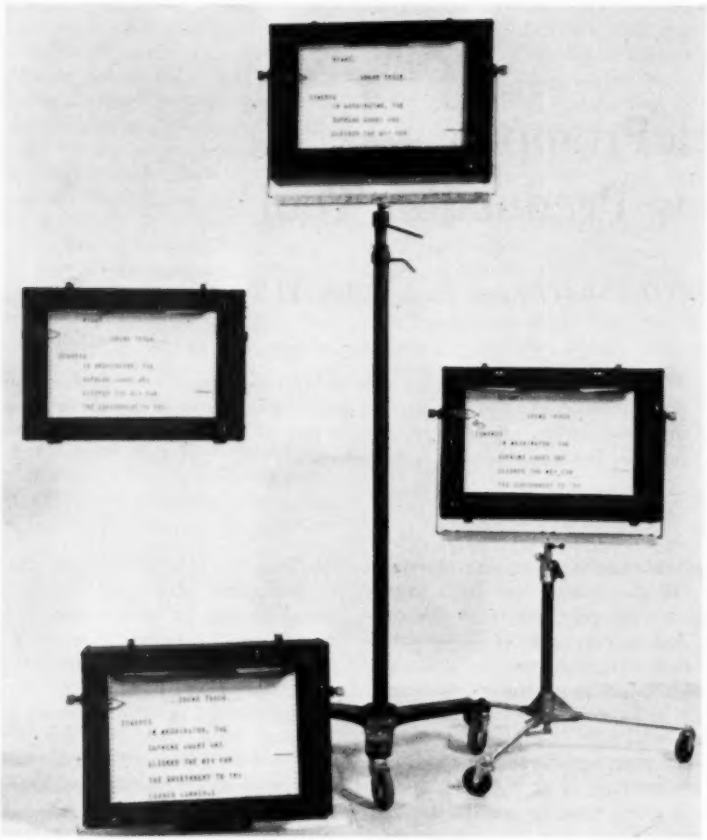


Fig. 1. A group of four TelePrompter reader units illustrating various methods of mounting for studio use.

in a studio greatly reduces the probability that prompting of any nature will be required.

Prompting devices are not new — many methods have been tried throughout the history of entertainment and public speaking. The most familiar of these methods, as far as the public is concerned, is typified by the old prompter's box. Unfortunately, the prompter's hoarse whisper was often as audible to the audience as was the actor's uncomfortable predicament. Even so, the prompter was one of the higher-paid members of the cast. Projection devices of one sort or another have been tried repeatedly, but because of their bulk and the difficulty of making changes they are not in common use. The electronic age contributed a tiny radio receiver with a speaker hidden in the ear of the performer. This method removed the audibility of the cue, but more often than not it distracted the performer with unwanted promptings and confusing instructions, and it bur-

Fig. 2. Master control, operator and monitor TelePrompter. The operator's hand is on the throttle-type speed control.

dened him with equipment that must be hidden on his person.

A careful and lengthy study of the problem pointed out the requirements for a prompting device which would have the features and flexibility necessary to contribute to modern production techniques. This study revealed that, as a primary requisite, a prompting device must be always ready and available for the performer's use if he desired to refer to it without betrayal of that fact to the audience, but it must be a device which could be completely ignored by the performer if he did not need a reference. This basic demand governed the choice of the fundamental TelePrompter design, a design which has successfully withstood the trial by fire of studio use, with only an evolution of details to meet the great variety of individual studio situations that have been met. The TelePrompter is in effect a multiple reader. A number of reading units, usually four for normal studio work as shown in Fig. 1, which are small enough and light enough to be strategically positioned about a set or moved with the action during the shooting, contain the script and acting and production cues. A master control unit, seen in

Fig. 2, comprises the fifth item of equipment in an operational group.

The script is written in large clear black letters on a yellow, glare-free, noncrinkle paper especially developed for this application. The type is front illuminated by self-contained incandescent lights which can be varied in intensity. Front illumination was chosen because it preserves contrast ratio and because it is helped rather than hurt by other studio illumination. Extensive readability tests have been conducted to determine the most favorable combination of the variables affecting vision. The large type is readable without effort by persons having normal or corrected normal vision at 25 ft, a distance that has been found to be quite adequate for the great percentage of studio shots. For an occasional cue many performers have found that distances considerably in excess of this figure are quite satisfactory. The use of low-power enlarging lenses in front of the script, while possible, is discouraged, except on rare occasions. Not only do such lenses add to the bulk and weight of the unit, but they pick up surface reflections, introduce flare and geometric distortions, and so limit the viewing angle that readability generally decreases in spite of the apparent increase in letter size. In those cases where letters larger than the standard Videotype size are required, it is preferred that larger original type be used. Such type is now in the process of being prepared for the electric "Videoprinter" which has been developed for TelePrompter Corporation.

Eight or more lines of script, depending on spacing, are visible to the actor at any one time with the "hot" line, that is the line currently being spoken, indicated by a large red arrow. Thus, the performer is at liberty to precue himself and is not limited to the "hot" line or word only. The script in each reader is printed on a continuous strip of paper which normally passes over the flat reading surface from a supply roller at the bottom to a take-up roller at the top of the machine. In special cases this direction of motion and the direction of script continuity can be reversed.

The use of multiple units is basic to this prompting technique because it frees the performer from the necessity of referring to a particular location on the set. He is at liberty to allow his glance to fall here or there or wherever the director has determined during rehearsal would be the most natural direction for such a glance. Even when the performer is playing to the camera lens, one of the TelePrompter units can be positioned so close to the lens, as shown in Fig. 3, that the slight angular difference in his glance is not significant. In fact, it is convenient to position the "hot" line immediately adjacent to the taking lens itself. The use of multiple units, however, imposes an operational requirement for line-by-line synchronism of the script in the several units so that quick reference may be made from one to the other without losing the place (see Fig. 4).

Several means of synchronizing motion of the script in the individual machines were considered. The most obvious method perhaps would be a pin and sprocket hole arrangement with friction drive of the take-up roll similar to the motion picture projector. This method was discarded for several reasons: it is not suitable for operating over the great range of speeds that are required; the pins demand precise location of the paper on the rollers and precise alignment of inserts and changes; stretch and shrinkage of paper as a function of weather make loading difficult; full drive power must be transmitted to the paper by small-diameter pins in a few sprocket holes; and misalignment of the paper or rollers can cause noise and even tearing of the paper. In the TelePrompter the take-up roller is driven by direct gearing to the motor pinion. Tension is applied to the paper by friction braking of the

supply roller. For reversing, the motor pinion is caused by remote control to disengage the take-up gear train and to engage the gear train of the supply roller. In either forward or reverse, one-way clutches remove friction from the drive roller and apply it to the feeding roller.

Torque for each machine is provided by a small-size selsyn motor connected electrically to a large self-synchronous generator in the master control unit. The generator is motor driven through a mechanical speed changer which is

Fig. 3. The small Model 3 TelePrompter reader with camera mount attachment on the friction head can position the "hot" line immediately adjacent to the camera lens.

Fig. 4. Dramatic shows such as the *First Hundred Years* make use of the TelePrompter.

continuously variable from zero to maximum speed. Various simplifications of this drive system are, of course, available at the cost of certain operational features. This drive system was chosen not only because of the synchronous rotation of all rotor shafts in the system, but because the motors operate well over a great range of speed and are quiet, both mechanically and electrically.

While the self-synchronous system provides the basic unit synchronism, it does not protect against insertion errors or cumulative errors of line spacing in the printing or slight differences in paper tension. A further precaution was added not only to guarantee the line-for-line synchronism required, but to provide an additional degree of flexibility of individual unit control. This feature consists of small conductive strips placed at short intervals along the script. Normally these so-called synchronizing marks are placed in identical positions on the several script copies. As the paper travels past the reading aperture a pair of contacts engages these marks making a temporary electrical circuit. Should one machine reach a particular synchronizing mark on its script before that point has been reached in the other machines, a relay circuit operates causing that machine to stop. When all machines have reached that identical point in the script, a reset relay operates and they continue resynchronized. Normally synchronization marks are located at periodic intervals of about four feet.

Mention has been made of the "great range of speed" required in operation of the machine. Possibly some explanation is required on this point. An operator, located at the master unit, has control not only of the TelePrompter lighting, cue lights, synchronization and mode of operation, but also of the speed of the script motion. This operator is, if you will, the accompanist. He regulates the speed of the script so that the "hot" line is always on the red arrow indicator of his monitor unit. If there is no dialogue at a particular moment or if the actor chooses to ad-lib, script speed may be zero. With normal monologue the speed may be very slow. A lively dialogue may require a speed several times normal, and a program cut or change in continuity (even that happens occasionally while "on the air") may require a speed many times normal. Rehearsals, of course, place a maximum demand on speed variations since the script must be brought forward or reverse to any particular spot for a run-through in less time than the other studio preparations can be made for that run-through.

An important feature of a modern prompting device is speed not only in preparation of the script, but speed in making changes. TelePrompter scripts are prepared by an electric "Videoprint" typewriter with paper supplied in fanfold packs for an original and three carbon copies. The carbons have been chosen by laboratory tests for good contrast and the copies are in fact hardly discernible from the original. Although the paper and type size of the "Videoprinter" is large, it has a standard typewriter keyboard and is operated easily and conveniently by any typist.

Small script changes can be made simply by an ink-brush write-in either directly on the paper or on a cloth adhesive tape placed over the changed word or line. Larger changes are made by removing or inserting complete panels in the paper. A panel consists of one fold of the original paper, an eight-inch length for the standard TelePrompter. The paper is supplied by the manufacturer with accurate horizontal perforations between panels for ease in tearing out sections.

Accessories for studio operation include various types of mobile and stationary stands or stand attachments for mounting the TelePrompter units. A newly developed camera mount, used to support

the TelePrompter, shown in Fig. 3, is the most recent addition to the accessory line. This mount is installed between the friction head of the pedestal or tripod and the camera. It permits quick and easy adjustment of the center of gravity of the camera so as to balance the weight load of any other camera accessory with respect to the axis of tilt. A TelePrompter unit can be supported by this mount so that it is fixed with respect to the taking lens, regardless of camera motion. Furthermore, it is supported in this position without hindering the operation or accessibility of the camera in any way, and without obstructing the view of the cameraman, while retaining perfect balance of the camera on the friction-head assembly. Although developed primarily for the TelePrompter, the camera mount already is a ready and excellent solution to other camera-balancing and accessory-mounting problems and is now being used for that purpose.

The TelePrompter is a modern solution to an old problem that has been aggravated by urgent production schedules. It is a new tool, flexible enough to be fitted to particular production problems, placed at the disposal of the director to save time, to reduce tension and to help achieve a smooth performance.

The Synchro-screen as a Stage Setting for Motion Picture Presentation

By BENJAMIN SCHLANGER, WILLIAM A. HOFFBERG and CHARLES R. UNDERHILL, Jr.

The Synchro-screen* is described as consisting of a motion picture screen with contiguous reflecting side wings, top and bottom panels. The picture surround surfaces synchronously fluctuate in light intensity and color with the changes in picture light and color adjacent to the reflecting surround areas. There is an appreciable increase in the subtended angles of the luminous field of view of the theater patron. A luminous, maskless stage setting is thus created for the viewing of motion pictures.

IT IS A WELL-KNOWN FACT that ophthalmologists, and others concerned with the care of the eyes, do not advise any condition where there is a high central but inadequate peripheral illumination. Reading a book or working under a shaded lamp in an otherwise darkened room is known to cause eye fatigue and even injury. The conventional black masking used with the motion picture screen is a glaring example, on a larger scale, and has been denounced by lighting specialists for years.

Luckiesh and Moss[1] have proven that certain eye muscles become fatigued from strain under the condition of dark surroundings and that the strain is relieved when there is some general peripheral lighting available without changing the brightness of the central objects. Employees in modern industry are no longer required to work under purely localized light sources, because employers know that the effects of dark surroundings for any visual task are psychologically depressing and that associated eyestrain and fatigue will result. The armed forces have given much thought to avoiding a dark surround on certain instrument panels and radar screens by incorporating a lumi-

Presented on April 22, 1952, at the Society's Convention at Chicago, by R. H. Heacock for the authors, Benjamin Schlanger and William A. Hoffberg, Theatre Consultants, 35 W. 53d St., New York 19, N.Y., and Charles R. Underhill, Jr., Radio Corporation of America, RCA Victor Div., Engineering Products Dept., Camden, N.J.

* Manufactured for and distributed by RCA.

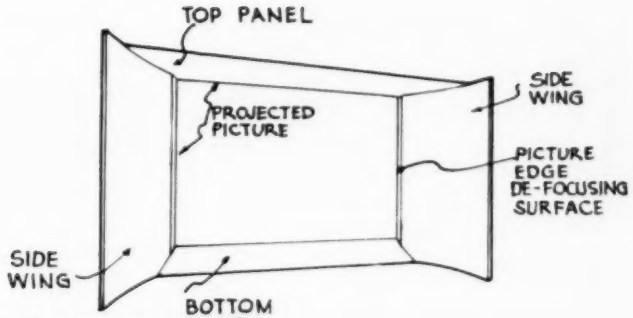


Fig. 1. The RCA Synchro-screen.

nous surround area in the design of military equipment.

Manufacturers of home television receivers were quick to recognize the importance of having the most favorable viewing conditions for a highly competitive product. An obvious difference in the viewing of home television and theater motion picture images is that home television receivers generally have light gray masks, whereas the conventional motion picture screen has black masking — a device as old as the motion picture industry.

The viewing of motion pictures in theaters is one of many visual tasks that are performed daily for prolonged periods by millions of people. Audiences, from the earliest days of the art, have never complained about prevailing lighting conditions until they have had better conditions for comparison. It is then that the older conditions are judged primitive. Therefore, the public has been inclined to accept black masking on motion picture screens, just as it has accepted primitive lighting conditions in other fields.

The Synchro-screen completely eliminates the black masking and complies very effectively with two distinct steps in the disposition of lighting as suggested by Luckiesh and Moss[1]:

(1) the attainment of maximal visibility within the central field without regard to the surroundings and

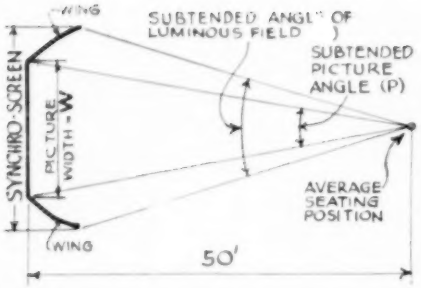
(2) the lighting of the surroundings in such a manner as to produce maximal comfort and ease, and minimal loss of visibility in the central field.

The first step is effectively attained by the use of a gradationally perforated sound screen known commercially as the Evenlite screen.[2] The design of the surround, which is the outstanding feature of Synchro-screen, adequately meets the requirements specified in the second step. The necessity of coordinating the requirements of both steps in the design of a screen stage setting is emphasized in the words of Luckiesh and Moss[1]:

"The important positive contribution to the lighting of the surroundings is the creation of conditions that will provide maximal visual and mental relaxation, minimize eye strain and fatigue without causing undue distraction from the picture, and promote safety. This means a proper balance or compromise of these factors."

In connection with these conditions, they have noted that the use of fixed, colored light appears unadvisable in the surrounding field for the same pyscho-physiological reason as darkness and glaring sources. By reflecting the light and color of the projected picture to the surround, the Synchro-screen has avoided this disadvantage.

Fundamentally, a Synchro-screen stage assembly consists of the main



SUBTENDED ANGLES L & P						
	№ 10 WING		№ 8 WING		№ 7 WING	
	24'W	20'W	20'W	16'W	16'W	12'W
L	45°32'	40°46'	36°52'	32°2'	30°14'	25°20'
P	27°0'	22°38'	22°38'	18°10'	18°10'	13°42'
L/P	1.69	1.80	1.63	1.77	1.67	1.85
AVERAGE INCREASE = 73% = $\left(\frac{L-P}{P}\right)$						

Fig. 2. The proportion of luminous surround area to picture area varies from 90% to 120% based on subtended horizontal and vertical angles of Synchro-screen from above seating position.

picture screen and frame to which is added a surround screen area comprising two side wings, a top panel and a bottom panel, as shown in Fig. 1. The two wings, as well as top and bottom panels are basically screens and frames of special designs, so that the stage setting assembly consists essentially of five screen surfaces and frames arranged in a definite relation to each other and to the projected picture light. In the same manner that the conventional black masking reduces slightly the maximum projected picture area for the purpose of concealing the projected edges of the picture aperture, so are the four surround panels of Synchro-screen set to enclose a picture area slightly smaller than that projected, in order that the edges of the projected picture will fall on the surround screens very close to their inside edges. The design and positions of the surround screens cause the image of the picture edges to be so completely out of focus that no borders are discernible from the seating area. Neither colored aberration edges nor borderline picture jump are noticeable.

The screen surfaces of the surround area receive and simultaneously reflect diffused light from the relatively adjacent areas on the picture screen in such a manner that the intensity of light and the predominant color of the adjacent picture area are reflected *synchronously* from the surround panels to the audience as a blended extension of the picture in light intensity and hue. At no time during the presentation of a picture on the Synchro-screen is the brightness of the surround area as bright as the nearest area of the picture. Therefore, there is never any distraction of the attention from the picture itself.

It can be seen from Fig. 2 that there is an appreciable and dramatic increase in the luminous field of view produced by the Synchro-screen. The picture seems larger and therefore closer to the audience because the subtended picture angle is related by the eye to the synchronous, luminous surrounding field which has a subtended area of from 90% to 120% of the picture area. The average increase in subtended horizontal angle to the luminous field is about 73% and produces a strong horizontal extensional effect which approximates the relatively subdued luminosity of the monocular portion of the field of view.

Synchro-screen Stage Setting Assemblies are manufactured as a complete package in 17 sizes, beginning with a minimum projected picture width of 12 ft and increasing by 1-ft width steps up to about 30 ft as a practical limit.

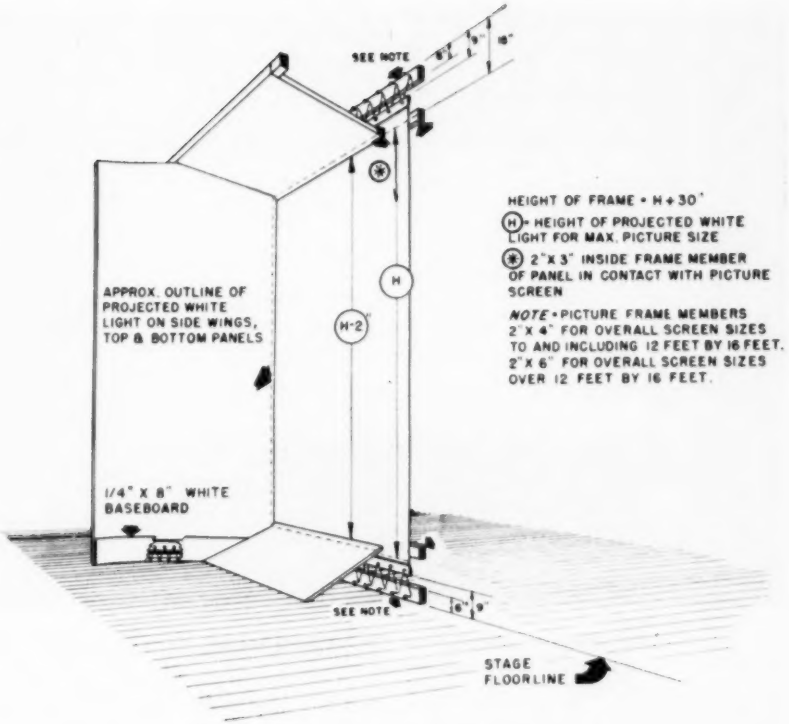

SEE NOTE
HEIGHT OF FRAME = H + 30"
(H) = HEIGHT OF PROJECTED WHITE LIGHT FOR MAX. PICTURE SIZE
(*) 2"X 3" INSIDE FRAME MEMBER OF PANEL IN CONTACT WITH PICTURE SCREEN
NOTE - PICTURE FRAME MEMBERS 2"X 4" FOR OVERALL SCREEN SIZES TO AND INCLUDING 12 FEET BY 16 FEET. 2"X 6" FOR OVERALL SCREEN SIZES OVER 12 FEET BY 16 FEET.
APPROX. OUTLINE OF PROJECTED WHITE LIGHT ON SIDE WINGS, TOP & BOTTOM PANELS
H
H-2"
1/4" X 8" WHITE BASEBOARD
SEE NOTE
STAGE FLOORLINE

Fig. 3. Relation of panels to picture screen.

The picture screen, as previously mentioned, is the Evenlite screen described in a paper presented at the April 1951[2] meeting of this Society. The fact that this screen has no perforations in the side areas has three important effects: firstly, the screen material of the wings exactly matches the sides of the picture screen; secondly, the side areas of the picture screen reflect the maximum amount of light so essential for optimum illumination of the surround; and thirdly, the Evenlite screen has been found to be a practical solution to the problem of obtaining an optimum screen brightness of an essentially uniform value in foot-lamberts from all points on this screen's surface.

Synchro-screen shipments are made knocked down. Total shipping weight for a picture size of 15 by 20 ft is about 800 lb. The five screen surfaces used in the complete assembly are shipped in tubes and the structural frame members are strapped into bundles with the exception of the top and bottom panel frames which are prefabricated into half sections for more rapid assembly on the job. Hardware is included in a kit of assembly parts and instructions. All members are lettered for ready identification and match marked for easy assembly. Basically, the installation of a Synchro-screen requires the erection of five frames and screens of various sizes (comprising the picture screen, the left and right side wings, the top and bottom panel) with wings and panels in

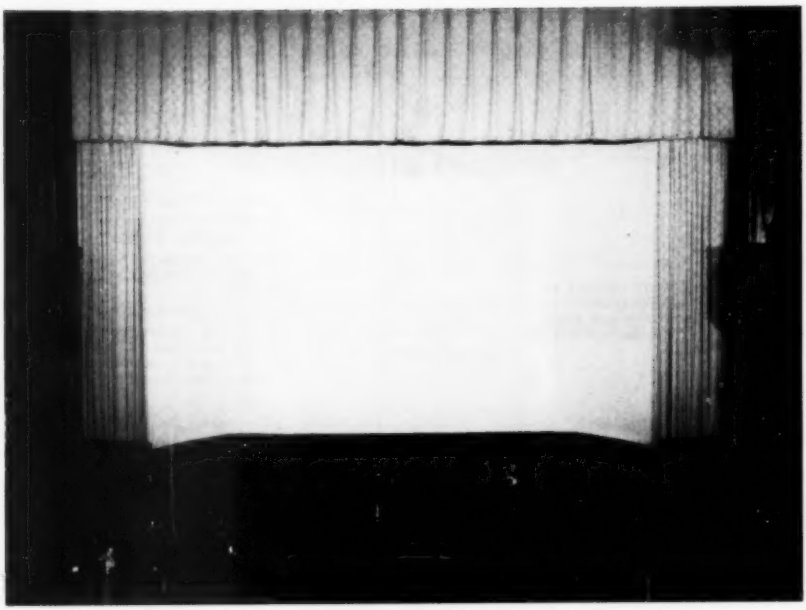


Fig. 4. Synchro-screen installed in the Plaza Theatre, New York City.

proper relation to the picture screen (Fig. 3). The picture screen is face-laced to bring the screen surface in a plane where the wings and panels can be in close contact. The screen material is Firestone Velon made to RCA specification. It is wrapped around those edges of the wings and frames which are in contact with the picture screen or exposed to view.

Architecturally, the Synchro-screen presents the appearance of an orderly, organized and attractive stage setting for motion picture presentation. It offers an economical method of creating a new atmosphere in the zone of maximum patron attention in the auditorium. The use of a draw curtain in front of the Synchro-screen has been found to have dramatic value, especially when the large luminous reflecting surfaces gradually come into view as the performance begins. A photograph of a Synchro-screen installation (Fig. 4) in the Plaza Theatre, New York, illustrates the use of a curtain and valance of a light gold-tint material.

Without an interest in or prolonged attention to the picture presentation (conditions which a theater patron assumes), an initial and momentary casual appraisal of the surround surfaces may result in a negative first impression, such as one of distraction. However, it must be remembered that the patron desires to concentrate on the main picture dramatic development. At such times, the Synchro-screen surround areas are in the peripheral field of view since the human field of view tends to become narrower when pyschological concentration exists. Distraction is completely eliminated when concentration occurs.

That the Synchro-screen is easier on the eyes, gives the effect of better color,

causes an illusion of added width and height, and creates an atmospheric effect is repeatedly attested to by patrons in unsolicited statements to theater personnel. From an audience reaction viewpoint, estimated as at least 100,000 persons to date, Synchro-screen has proven to be a major improvement in the presentation of motion pictures in theaters.

References

1. M. Luckiesh and F. K. Moss, "The motion picture screen as a lighting problem," *Jour. SMPE, 26:* 578–591, May 1936.
2. C. R. Underhill, Jr., "Practical solution to the screen light distribution problem," *Jour. SMPTE, 56:* 680–683, June 1951.
3. B. O'Brien and C. M. Tuttle, "Experimental investigation of projection screen brightness," *Jour. SMPE, 26:* 505–517, May 1936.
4. B. Schlanger and W. A. Hoffberg, "New approaches developed by relating film production techniques to theater exhibition," *Jour. SMPTE, 57:* 231–237, Sept. 1951.
5. B. Schlanger, "A method of enlarging the visual field of the motion picture," *Jour. SMPE, 30:* 503–509, May 1938.

Discussion

R. H. Heacock: You know, Barton, I have a confession to make about Synchro-screen. I, like most of you, have heard Ben Schlanger talk about light surround areas as applied to motion picture screens for some years. Since there are very few new theaters that can be constructed like that at Framingham (which was originally designed and built for a light surround screen), as compared to our twenty-thousand existing theaters, my interest was only academic.

From a practical viewpoint, another factor colored my reaction to Ben's ideas. I think most of you have experienced what I refer to. We are told most seriously of the marked advantages of the dissolving action of double shutter projectors; of the greater, whiter light of a certain arc lamp; of the longer, flatter response curve of a particular theater sound system. And yet we who tell you of these wonders would be hard pressed to tell you with absolute certainty specifically what equipment was in the booth of a particular theater where you might ask us to see and hear a current Hollywood release with you.

Last fall I saw the first installation of Synchro-screen. Each time I watch another picture on this screen I become more convinced that this packaged stage setting will do more to improve an existing theater's film presentation than the same amount of money could if spent for any other improvement.

Each of you has been given a courtesy admission card at the time of registration to the Palace Theatre to see an actual operating theater equipped with Synchro-screen. If you want to see how a technical idea has been adapted to actual operating conditions, take a ten-minute cab ride, see one reel of the feature, and then we believe you will understand the great interest in this practical modern method of stage setting for presentation of our current Hollywood productions.

W. R. Cronenwett: I'd like to ask whether Synchro-screen equipment can be so designed to be flown to a grid?

Mr. Heacock: It probably can, but at the present time we do not have such equipment. Our current installations are set up and are rigidly assembled to the stage floor. With any special requirements like that, we would be very happy to discuss them in detail with you and I think it's always possible to overcome difficulties of that kind if there is money enough in the kitty to pay for this special feature.

J. A. Tanney: Does the name Synchro-screen come from the fact that the lighting in the surround varies with the brightness of the image on the screen?

Mr. Heacock: That's exactly right. In England I saw a write-up in the *International Projectionist* where they took the light from the frame that was four frames above the actual projected picture. Some of the light was diverted up through an associated optical system and then projected around the edges of the main picture screen. My interpretation of that article would be that if we had a Technicolor feature, we would have a surround area that would be a blend of all of the colors in that particular frame. One other thing, it is out of sync by the amount

of four frames. For those of you who may have seen the *Desert Fox*, there was quite a sequence of an artillery barrage where you would see a blast of light and in silhouette, a gun crew in this corner of the picture screen and in a fraction of a second there would be another flash of light up here, and finally there were flashes here, here and here. I happened to see that on Synchro-screen and, of course, in exact synchronization the whole area of the side wings and bottom wings flashed into view here and up here, then here, and then over here, so that truly the word Synchro-screen is not just a trick name, but has meaning. The surround areas are in perfect synchronization not only with light variation but also with variation in color intensity.

If the area at the left side is blue, the wing on that side is blue. If the upper righthand corner is dark red, the surround area there is dark red.

Anon: Where can this screen be seen in New York?

Mr. Heacock: The Plaza Theatre on 58th Street and Madison Avenue has the Synchro-screen, as does the Plaza in Scarsdale, New York.

R. L. Estes: I'm interested in knowing how the light surround reflected from the wings affects the shadow detail and also what is the effect of viewing from different angles the width of the wings?

Mr. Heacock: Although I have seen six or eight different feature films in various theaters equipped with Synchro-screens, I have not been aware of any washing out of the picture at the edges. Although theoretically a very small amount of light might be diffused back on to the edges of the main picture screen, from a practical viewpoint this effect is not perceptible. I have not heard any criticisms of the screens in this respect from any others who have seen them.

When I first saw Synchro-screen, I moved around from the center of the balcony to the sides of the balcony, to close-up on the right, and close-up on the left. There is a variation. There is a change, but I didn't sit in any seat where I had any but a favorable reaction and my own feeling was that here was something that would really have popular appeal. I believe that your question depends a great deal on your own personal reaction; consequently, I strongly recommend that you go down to the Palace Theatre here in Chicago and check into each of these points, and I shall be very much interested in hearing of your own personal conclusions.

You'll notice in the advertisements of the Palace Theatre — I cut this out of the paper this morning — it says here in capital letters: SEE THIS GRAND PICTURE ON OUR NEW THREE-DIMENSIONAL SYNCHRO-SCREEN. We know that this is not three-dimensional, but I think if you happen to see a picture — the ballet sequence in *An American in Paris* was mentioned here this morning by Mr. Handley — you would be almost willing to declare that you did see a three-dimensional picture. But it's the same picture on the same plane, flat picture screen. The psychological effect of the light surround area, I do think, tends to help in your feeling of a three-dimensional effect. But technically, of course, it is not.

C. L. Greene: Is there, in Chicago, an installation of Ben Schlanger's original type of screen, where the margins of the screen transmitted some picture light to a reflective surface behind it, a specular reflecting surface which then reflected that light out on to side wings.

Mr. Heacock: I do not believe there is. I don't know if there is such an installation.

Mr. Greene: That was demonstrated with a model in New York, I believe, in 1937. I heard the comment repeated many times at that meeting, that that was the greatest advance in picture presentation since the coming of sound. Personally, I still subscribe to that opinion. It is not flattering, I think, to the exhibition branch of the industry that it has shown an almost psychopathic fear of advancements such as this. I am in a way sorry to see it come in a package form which I fear is not the equal of Mr. Schlanger's original design, but at the same time I am happy to see the industry accept any improvement.

Mr. Heacock: Well, go down to the Palace and see how you like it. I'll be very much interested in talking to you about it.

Resolution Test Chart of the Motion Picture Research Council

THE MOTION PICTURE RESEARCH COUNCIL has announced the preparation of a resolution test chart designed primarily for the use of studio camera departments. When mounted in front of a 35mm camera lens at a distance in inches equivalent to the focal length of the lens in millimeters, its image exactly fills a standard 35mm aperture (American Standard Z22.59-1947). Resolution test figures in key positions over the field will then indicate limits of resolution directly in lines per millimeter. Other test patterns give qualitative indications of serious aberrations or other lens defects while carefully designed focus figures at the center and each corner assist in studies involving depth of focus and curvature of field.

Although designed primarily for use with 35mm camera lenses, the chart may be used satisfactorily with any photographic lens. It may not fill the field at the specified distance, but simple conversions of the indicated scale units can be used without difficulty. An illustration of the chart is included. It is printed on white card and has an overall dimension of approximately 16 by 22 in. Copies may be obtained for $3.00 each, postage prepaid, directly from the Motion Picture Research Council, 1421 North Western Ave., Hollywood 27, Calif. "Directions for Use" accompany each chart.

Articles describing the development and construction of the chart have been published:

1. Armin J. Hill, "A new resolution test chart for motion picture camera lenses," *Phot. Sci. and Tech. (Sec. b, PSA Jour.)*, *17:* 68–70, Sept. 1951.
2. Armin J. Hill, "A resolution test chart for motion picture cameras," *Am. Cinematographer*, *32:* 402, Oct. 1951.

Fig. 1. Detail of focus figure.

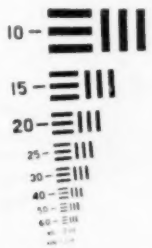


Fig. 2. Enlarged detail of the resolution pattern.

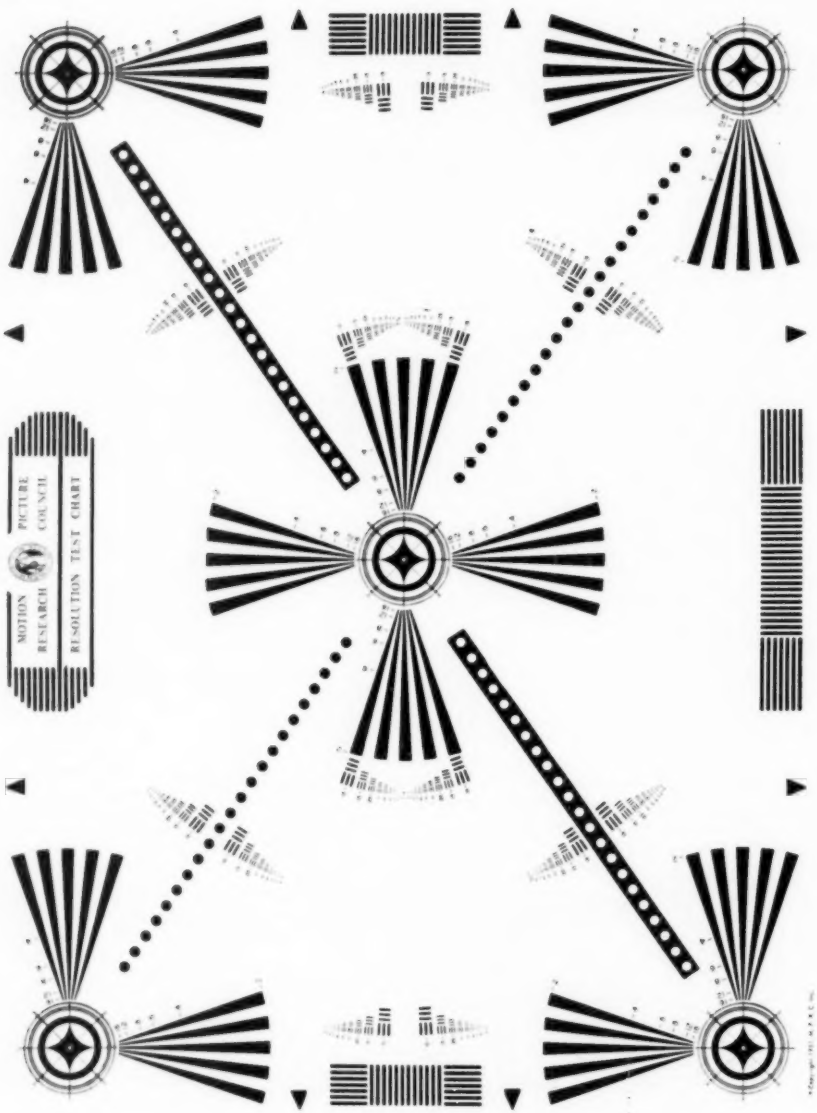


Fig. 3. Motion Picture Research Council Resolution Test Chart

Laboratory Practice Committee Report

By JOHN G. STOTT, Committee Chairman

THIS COMMITTEE was organized under its present Chairman and Committee personnel early in 1949. The original agenda of this Committee was thought to be concerned primarily with chemical and chemical engineering problems associated with the motion picture industry. The proposed agenda was directed into these particular channels primarily because the membership of the Committee was composed largely of chemists and chemical engineers working in motion picture laboratories. The first meeting of this Committee, however, brought out rather clearly that there were many problems to be considered before too much effort was expended on purely chemical and chemical engineering problems.

At the Committee's first meeting the following proposed agenda was laid out:

1. Design of a special leader for television films to replace the Academy theater leader.
2. Aid in the standardization of screen brightness for 16mm projection.
3. Establishment of a standard for the notching of 35mm and 16mm negative films.
4. Investigation of the possibility of modifying sound and picture reduction printers to print forward and backward and to employ 2000-ft negative feed and take-up.
5. Investigation of the standardization of edge numbering of 16mm films.
6. Study recommendations for the splicing of 16mm films.
7. Study 16mm projection emulsion position.
8. Study methods of bringing data on chemical and chemical engineering developments to the attention of Society members.

This Committee is able to report as follows on the agenda laid out early in 1949:

1. A special leader for television films to replace the Academy theater leader has been designed, submitted to the membership of the Society for comment, has been approved, and is currently in widespread use throughout the industry. The work on this leader has been carried out by the Leader Subcommittee of the Films for Television Committee under the Chairmanship of Charles Townsend. The representative from the Laboratory Practice Committee on the Leader Subcommittee was V. D. Armstrong.

2. A subcommittee on 16mm review-room screen brightness of the Laboratory Practice Committee under the Chairmanship of O. E. Cantor has

Presented on April 24, 1952, at the Society's Convention at Chicago, Ill., by John G. Stott, DuArt Film Laboratories, 245 W. 55 St., New York 19, N. Y.

drafted a Proposed American Standard for screen brightness of 16mm laboratory review rooms. One criticism of the Proposed Standard concerns the discrepancy between the established standard for 35mm and the proposed standard for 16mm. It is felt, however, that due to the extremely difficult conditions under which 16mm films are projected, particularly in Armed Forces installations, a screen brightness standard identical to the 35mm standard would in most cases be unattainable and hence, unrealistic. The problem is further complicated by the amateur and television fields.

3. The Proposed American Standard on Size and Location of Notches for 35mm Negatives was drawn up by Paul Kaufman and was submitted to the Laboratory Practice Committee for balloting. Considerable opposition to the Standard arose from the Committee members because many printers in the industry could not be made to conform to this Standard without extensive and expensive alterations. It was also learned that many thousands of reels of negatives are presently stored in laboratory vaults from which prints are ordered from time to time, these negatives being notched in accordance with past practice and hence, in many cases being notched contrary to this proposed Standard.

At a later meeting of the Laboratory Practice Committee it was decided that it would, at the present time, be impossible to arrive at any compromise which would make it desirable to adopt this Standard. It was also felt that it would be much simpler to establish a standard for 16mm films since the need for a notching standard in 16mm is so urgent. Further observations were that the method of "notching" would have to be totally different and distinct from past methods and also essentially noninterfering with presently notched films in order to make the establishment of a standard even remotely possible.

Lloyd Thompson had been working on other means of "notching" 16mm films and offered to turn over to the Society any methods, patents or licenses, free of charge, providing this information would aid in the establishment of an American Standard. Mr. Thompson, after a great deal of research and development, has devised a means of actuating light-change mechanisms by means of applying an electrical conducting material to the emulsion of the film which may be used as a cueing device for such light-change mechanisms. Mr. Thompson has prepared a report outlining the history and background of printer light-change cueing methods and proposals and has drawn up a Proposed American Standard. This report is complete in all respects including drawings of the mechanical elements required, amplifier circuits, parts list and approximate prices. This report was submitted to the Laboratory Practice Committee for balloting early in April 1952.

This Proposed American Standard makes it possible to provide printer light-change cueing of 16mm negatives whether they have been notched before or not. It is hoped that when this method of cueing of 16mm negatives has been adopted as an American Standard, the same technique may be applied to 35mm, thus solving the 35mm notching problem.

4. The manufacturers of motion picture printers were contacted regarding the possibility of modified sound and picture reduction printers to print forward and backward and to employ 2000-ft negative feed and take-up. It was the unanimous opinion of the equipment manufacturers that modification of sound and picture reduction printers now in use to print forward and backward would entail extensive modification of present equipment and would involve considerable increase in price in future models. It was the opinion

of the Committee membership that it was not a function of the Laboratory Practice Committee to propose to equipment manufacturers changes of this type, but was rather a matter concerning negotiation between equipment manufacturers and the purchasers of the equipment.

With regard to the use of 2000-ft negative feed and take-up assemblies on these printers, it was learned that some manufacturers of this type of equipment were already turning out printers so equipped. Existing equipment in laboratories in many cases had been altered by their engineering departments. It was thus decided that this matter should be tabled.

5. At the time the Laboratory Practice Committee investigated the standardization of edge numbering of 16mm films, a Proposed American Standard was already in the process of being drafted by the 16Mm and 8Mm Committee of the Society. This Standard has now been submitted to ASA for balloting.

6. In spite of a great deal of discussion in Laboratory Practice Committee meetings, it was impossible to arrive at any conclusions regarding recommendations on the splicing of 16mm films. A standard for splicing of 16mm positive films was drafted by the 16Mm and 8Mm Committee and has just been approved as an American Standard.

7. The matter of 16mm projection emulsion position has been discussed thoroughly in several engineering committees of the Society including this one. A symposium on this problem was held at the Hollywood Convention in October 1951, but the matter seems still to be completely up in the air. It is certain that the entire membership of the Society is familiar with the problems of 16mm projection emulsion position and hence, no further amplification is required here.

8. Under the editorial direction of Irving Ewig, the Laboratory Practice Committee has been contributing to the *Journal* under the heading of "Chemical Corner" which includes suggestions, tips, new methods, new equipment and new techniques related primarily to chemical and chemical engineering problems. This project requires a great deal of time on the part of Mr. Ewig and it is hoped that Committee members and the membership at large of the Society will aid Mr. Ewig in this work by submitting interesting material.

Since this agenda was proposed, other projects have been referred to the Laboratory Practice Committee for comment and action.

At the Lake Placid meeting of the Committee on Color, it was pointed out that a definite need exists for the establishment of a standard magnification ratio for the production of 35mm color prints from 16mm preprint material. The Committee on Color recognized this as a laboratory problem and recommended that this project be assigned to this Committee. This project was undertaken by Gordon Chambers, who prepared a proposed 16mm optical printer aperture for enlargement printing to 35mm. This Proposed American Standard examines several possible solutions and recommends what appears to be the most logical choice. The Laboratory Practice Committee has been balloted on this Standard and, as a result of the voting, this Proposed Standard has been submitted to the Standards Committee for processing.

At the Convention held in Chicago in April 1952, another meeting of the Laboratory Practice Committee was held. At this meeting the Proposed Standard on screen brightness for 16mm laboratory review rooms was discussed at quite some length. Considerable opposition to the proposed brightness was raised because of the wide divergence from usual projection screen brightness

for 16mm amateur films. It was recommended that the Screen Brightness Committee as well as this Committee be balloted and that further action be held up until the results of the voting are known.

At this meeting it was also decided that this Committee would embark on a program of drawing up definitions or a system of nomenclature for all chemical operations found in motion picture laboratories in order to clarify terms in technical discussions and literature. Should this chemical glossary prove successful, future plans would include expansion of this glossary to include all laboratory products, equipment and functions.

Standards for Splices and Projection Reels

On April 30, 1952, the American Standards Association approved one new standard, PH22.77-1952, Splices for 8MM Motion Picture Films, and revision of two previous standards, PH22.24-1952, Splices for 16MM Motion Picture Films for Projection, and PH22.11-1952, 16MM Motion Picture Projection Reels.

All three standards were initiated and/or revised by the 16MM and 8MM Committee. The splice standards were published for trial and comment January 1951 and the reel standard first in February 1950 and again in February 1951 when the initial publication resulted in comments indicating a need for further revisions.

American Standard
for
16-Millimeter Motion Picture Projection Reels

ASA
Reg. U. S. Pat. Off.
PH22.11-1952
Revision of
Z22.11-1941
and
Z52.33-1945
*UDC 778.55

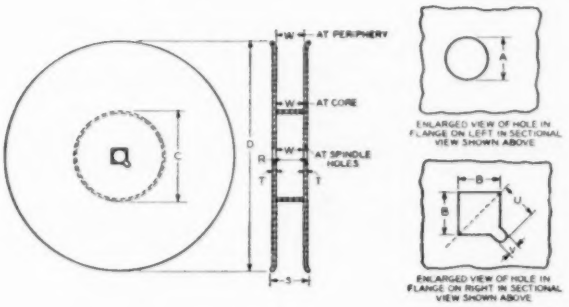


Table 1 See page 3 for notes.

Dimension	Inches	Millimeters
A	0.319 $^{+0.000}_{-0.003}$	8.10 $^{+0.00}_{-0.08}$
B	0.319 $^{+0.000}_{-0.003}$	8.10 $^{+0.00}_{-0.08}$
R[1]	0.790 maximum	20.06 maximum
S[2] (including flared, rolled, or beveled edges)	0.962 maximum	24.43 maximum
T (adjacent to spindle)	0.027 minimum 0.066 maximum	0.69 minimum 1.68 maximum
U	0.312 ±0.016	7.92 ±0.41
V	0.125 $^{+0.005}_{-0.000}$	3.18 $^{+0.13}_{-0.00}$
W, at periphery[3]	0.660 $^{+0.045}_{-0.025}$	16.76 $^{+1.14}_{-0.64}$
at core[4]	0.660 ±0.010	16.76 ±0.25
at spindle holes	0.660 ±0.015	16.76 ±0.38
Flange and core concentricity[5]	±0.031	±0.79

Approved April 30, 1952, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

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American Standard
for
16-Millimeter Motion Picture Projection Reels

ASA
Reg. U. S. Pat. Off.

PH22.11-1952

Table 2

Capacity	Dimension	Inches	Millimeters	Capacity	Dimension	Inches	Millimeters
200 feet[5] (61 meters)	D, nominal	5.000	127.00	1200 feet (366 meters)	D, nominal	12.250	311.15
	maximum	5.031	127.79		maximum	12.250	311.15
	minimum	5.000	127.00		minimum	12.125*	307.98*
	C, nominal	1.750	44.45		C, nominal	4.875	123.83
	maximum	2.000*	50.80*		maximum	4.875	123.83
	minimum	1.750	44.45		minimum	4.625*	117.48*
	Lateral runout,[7] maximum	0.570	1.45		Lateral runout,[7] maximum	0.140	3.56
400 feet[5] (122 meters)	D, nominal	7.000	177.80	1600 feet (488 meters)	D, nominal	13.750	349.25
	maximum	7.031	178.59		maximum	14.000*	355.60*
	minimum	7.000	177.80		minimum	13.750	349.25
	C, nominal	2.500	63.50		C, nominal	4.875	123.83
	maximum	2.500	63.50		maximum	4.875	123.83
	minimum	1.750*	44.45*		minimum	4.625*	117.48*
	Lateral runout,[7] maximum	0.080	2.03		Lateral runout,[7] maximum	0.160	4.06
800 feet (244 meters)	D, nominal	10.500	266.70	2000 feet (610 meters)	D, nominal	15.000	381.00
	maximum	10.531	267.49		maximum	15.031	381.79
	minimum	10.500	266.70		minimum	15.000	381.00
	C, nominal	4.875	123.83		C, nominal	4.625	117.48
	maximum	4.875	123.83		maximum	4.875	123.83
	minimum	4.500*	114.30*		minimum	4.625	117.48
	Lateral runout,[7] maximum	0.120	3.05		Lateral runout,[7] maximum	0.171	4.34

*When new reels are designed or when new tools are made for present reels, the cores and flanges should be made to conform, as closely as practicable, to the nominal values in the above table. It is hoped that in some future revision of this standard the asterisked values may be omitted.

American Standard
for
16-Millimeter Motion Picture Projection Reels

ASA
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PH22.11-1952

Note 1: The outer surfaces of the flanges shall be flat out to a diameter of at least 1.250 inches.

Note 2: Rivets or other fastening members shall not extend beyond the outside surfaces of the flanges more than 1/32 inch (0.79 millimeter) and shall not extend beyond the over-all thickness indicated by dimension S.

Note 3: Except at embossings, rolled edges, and rounded corners, the limits shown here shall not be exceeded at the periphery of the flanges, nor at any other distance from the center of the reel.

Note 4: If spring fingers are used to engage the edges of the film, dimension W shall be measured between the fingers when they are pressed outward to the limit of their operating range.

Note 5: This concentricity is with respect to the center line of the hole for the spindles.

Note 6: This reel should not be used as a take-up reel on a sound projector unless there is special provision to keep the take-up tension within the desirable range of 1½ to 5 ounces.

Note 7: Lateral runout is the maximum excursion of any point on the flange from the intended plane of rotation of that point when the reel is rotated on an accurate, tightly fitted shaft.

American Standard
for
16-Millimeter Motion Picture Projection Reels

ASA
Reg. U. S. Pat. Off.

PH22.11-1952

Appendix

(This Appendix is not a part of the American Standard for 16-Millimeter Motion Picture Projection Reels, PH22.11-1952.)

Dimensions A and B were chosen to give sufficient clearance between the reels and the largest spindles normally used on 16-millimeter projectors. While some users prefer a square hole in both flanges for laboratory work, it is recommended that such reels be obtained on special order. If both flanges have square holes, and if the respective sides of the squares are parallel, the reel will not be suitable for use on some spindles. This is true if the spindle has a shoulder against which the outer flange is stopped for lateral positioning of the reel. But the objection does not apply if the two squares are oriented so that their respective sides are at an angle.

For regular projection, however, a reel with a round hole in one flange is generally preferred. With it the projectionist can tell at a glance whether or not the film needs rewinding. Furthermore, this type of reel helps the projectionist place the film correctly on the projector and thread it so that the picture is properly oriented with respect to rights and lefts.

The nominal value for W was chosen to provide proper lateral clearance for the film, which has a maximum width of 0.630 inch. Yet the channel is narrow enough so that the film cannot wander laterally too much as it is coiled; if the channel is too wide, it is likely to cause loose winding and excessively large rolls. The tolerances for W vary. At the core they are least because it is possible to control the distance fairly easily in that zone. At the holes for the spindles they are somewhat larger to allow for slight buckling of the flanges between the core and the holes. At the periphery the tolerances are still greater because it is difficult to maintain the distance with such accuracy.

Minimum and maximum values for T, the thickness of the flanges, were chosen to permit the use of various materials.

The opening in the corner of the square hole, to which dimensions U and V apply, is provided for the spindles of 35-millimeter rewinds, which are used in some laboratories.

D, the outside diameter of the flanges, was made as large as permitted by past practice in the design of projectors, containers for the reels, rewinds, and similar equipment. This was done so that the values of C could be made as great as possible. Then there is less variation, throughout the projection of a roll, in the tension to which the film is subjected by the take-up mechanism, especially if a constant-torque device is used. Thus it is necessary to keep the ratio of flange diameter to core diameter as small as possible, and also to eliminate as many small cores as possible. For the cores, rather widely separated limits (not intended to be manufacturing tolerances) are given in order to permit the use of current reels that are known to give satisfactory results.

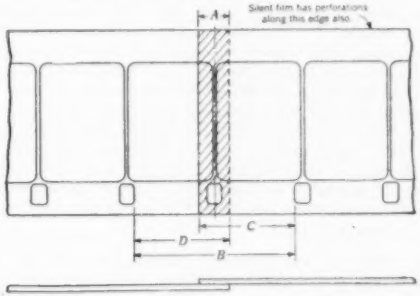
American Standard

Splices for 16-Millimeter Motion Picture Films for Projection

ASA
Reg. U. S. Pat. Off.
PH22.24-1952
Revision of
Z22.24-1941,
Z22.25-1941, and
Z52.20-1944
*UDC 778.55

Scope

Splices made in accordance with this standard are primarily for use with films intended for actual projection, such as release prints and reversal films. It is not intended that this standard be prejudicial to the use of diagonal-type splicers, nor to the use of narrower splices for professional purposes. For negatives and other laboratory films, narrower splices, sometimes with one edge on the frameline, frequently are used.



Dimension	Inches	Millimeters
A	$0.100\ ^{+0.000}_{-0.005}$	$2.54\ ^{+0.00}_{-0.13}$
B	$0.548\ ^{+0.001}_{-0.001}$	$13.920\ ^{+0.025}_{-0.025}$
C	$0.324\ ^{+0.000}_{-0.003}$	$8.23\ ^{+0.00}_{-0.08}$
D	$0.324\ ^{+0.000}_{-0.003}$	$8.23\ ^{+0.00}_{-0.08}$

Note 1: In the plan view, the splice is arranged with the perforations at the bottom in order to show them as they appear on most splicers. The splice may be made with the film turned through an angle of 180 degrees, or any other angle, but, of course, the emulsion surface should always be up. It is customary to scrape the top (emulsion) surface of the left-hand film and to cement this scraped area to the bottom (base) surface of the right-hand film.

(Continued)

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American Standard

Splices for 16-Millimeter Motion Picture Films for Projection

ASA
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PH22.24-1952

Note 2: Dimension A is given a negative, but no positive, tolerance because narrower splices are less conspicuous on the screen and are less likely to affect the normal curvature of the film as it follows the bends in its path through cine-machinery.

Note 3: Dimension B controls the longitudinal registration of the two films being spliced. It is measured to the perforations that are most commonly used for registration on splicing blocks, and to the nearer edges of these perforations because they are edges that are generally used for the registration. This dimension is made the same as in the American Standard Splices for 8-Millimeter Motion Picture Films, PH22.77-1952, because many splicers are designed to accept either 16- or 8-mm film.

The nominal value of the B dimension was made 0.548 inch instead of the usual 0.550 (for unshrunk film) because the films being spliced are always shrunk to some extent. The 0.548 figure corresponds to a shrinkage of 0.36 percent, while the 0.549 and 0.547 values, permitted by the tolerances, correspond to 0.18 percent and 0.55 percent, respectively. Thus, the tolerances include the range of shrinkage ordinarily encountered when film is being spliced.

Note 4: Dimensions C and D were chosen to give a straight 0.100-inch splice that is symmetrical about the included perforation (and, therefore, the frame-line) when the film is shrunk 0.36 percent. (See Note 3.)

Note 5: The width of the film at the splice shall not exceed 0.630 inch. If the film has been widened during scraping, the extra width shall be removed.

Note 6: The overlapping perforations of the two films shall not be offset laterally more than 0.002 inch.

Note 7: At the splice, the edges of the two spliced films shall not be offset laterally more than 0.002 inch, unless a difference in the lateral shrinkages of the two strips makes it impossible to maintain that tolerance. Shoulders formed by such misalignment shall be beveled after the cement has dried.

Note 8: In the plan view, the angle between the respective edges of the spliced films shall be 180 degrees, plus or minus 40 minutes. Thus, the spliced film shall be aligned to the extent that when one portion of the film is placed against a straight edge, the other portion will not deviate more than 0.006 inch (approximately the thickness of the film) in 6 inches.

Note 9: In order to prevent the appearance of a white line on the screen, the scraped area shall be 0.001 to 0.003 inch narrower than the area covered by the overlapping film. The presence of this narrow uncemented area will not shorten the life of the splice.

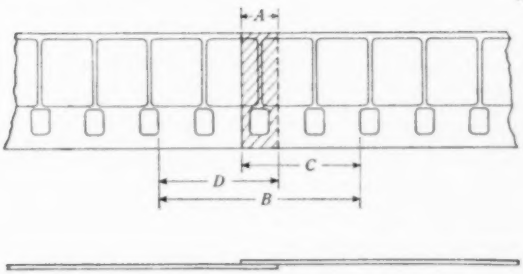
American Standard

Splices for 8-Millimeter Motion Picture Films

ASA
Reg. U. S. Pat. Off.

PH22.77-1952

*UDC 778.55



Dimension	Inches	Millimeters
A	$0.100\ ^{+0.000}_{-0.005}$	$2.54\ ^{+0.00}_{-0.13}$
B	$0.548\ ^{+0.001}_{-0.001}$	$13.920\ ^{+0.025}_{-0.025}$
C	$0.324\ ^{+0.000}_{-0.003}$	$8.23\ ^{+0.00}_{-0.08}$
D	$0.324\ ^{+0.000}_{-0.003}$	$8.23\ ^{+0.00}_{-0.08}$

Note 1: In the plan view, the splice is arranged with the perforations at the bottom in order to show them as they appear on most splicers. The splice may be made with the film turned through an angle of 180 degrees, or any other angle, but, of course, the emulsion surface should always be up. It is customary to scrape the top (emulsion) surface of the left-hand film and to cement this scraped area to the bottom (base) surface of the right-hand film.

Note 2: Dimension A is given a negative, but no positive, tolerance because narrower splices are less conspicuous on the screen and are less likely to affect the normal curvature of the film as it follows the bends in its path through cine-machinery. *(Continued)*

Approved April 30, 1952, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

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American Standard

Splices for 8-Millimeter Motion Picture Films

ASA Reg. U. S. Pat. Off.

PH22.77-1952

Note 3: Dimension B controls the longitudinal registration of the two films being spliced. It is measured to the perforations that are most commonly used for registration on splicing blocks, and to the nearer edges of these perforations because they are edges that are generally used for the registration. This dimension is made the same as in the American Standard Splices for 16-Millimeter Motion Picture Films for Projection, PH22.24-1952, because many splicers are designed to accept either 8- or 16-mm film.

The nominal value of the B dimension was made 0.548 inch instead of the usual 0.550 (for unshrunk film) because the films being spliced are always shrunk to some extent. The 0.548 figure corresponds to a shrinkage of 0.36 percent, while the 0.549 and 0.547 values, permitted by the tolerances, correspond to 0.18 percent and 0.55 percent, respectively. Thus, the tolerances include the range of shrinkage ordinarily encountered when film is being spliced.

Note 4: Dimensions C and D were chosen to give a 0.100-inch splice that is symmetrical about the included perforation (and, therefore, the frameline) when the film is shrunk 0.36 percent. (See Note 3.)

Note 5: The width of the film at the splice shall not exceed 0.317 inch. If the film has been widened during scraping, the extra width shall be removed.

Note 6: The overlapping perforations of the two films shall not be offset laterally more than 0.002 inch.

Note 7: At the splice, the edges of the two spliced films shall not be offset laterally more than 0.002 inch, unless a difference in the lateral shrinkages of the two strips makes it impossible to maintain that tolerance. Shoulders formed by such misalignment shall be beveled after the cement has dried.

Note 8: In the plan view, the angle between the respective edges of the spliced films shall be 180 degrees, plus or minus 40 minutes. Thus, the spliced film shall be aligned to the extent that when one portion of the film is placed against a straight edge, the other portion will not deviate more than 0.006 inch (approximately the thickness of the film) in 6 inches.

Note 9: In order to prevent the appearance of a white line on the screen, the scraped area shall be 0.001 to 0.003 inch narrower than the area covered by the overlapping film. The presence of this narrow uncemented area will not shorten the life of the splice.

71st Semiannual Convention

The several sources and aspects of the Society's overall interest were reflected from the opening Monday noon Get-together Luncheon right on through the eleven-session technical program organized by Program Chairman Geo. W. Colburn and held at The Drake in Chicago on April 21–25. Besides sessions arranged by topics such as television, screens, high-speed photography and usual motion picture subjects, one session was labeled as to source — the armed forces production session. The complete roster of the authors and their papers is given on later pages of this *Journal*.

Excerpted below are the convention introductory remarks by President Peter Mole, who also introduced the principal speaker, Dr. W. R. G. Baker, General Electric Vice-President and General Manager of its Electronics Div., Syracuse, N.Y. Mr. Mole noted that Dr. Baker, known for his pioneering in radio and television, has, among his numerous contributions to American industry, service as a key figure in the coordination of technical developments through the work of industrial and technical societies. He has been President of the I.R.E. and R.T.M.A. His speech on the work of the National Television System Committee is given in part below.

President Mole also welcomed Jimmy Frank as one who needs no introduction to old timers of the Society. He spoke as Deputy Director of the Motion Picture and Photographic Products Div. of the National Production Authority and his speech is excerpted below.

A lighter part of the luncheon program was the appearance of Leon Ames, motion picture actor then starring in Chicago's long-run stage performance of *The Moon Is Blue*. He came to the luncheon through the kindly offices of George Colburn to assure engineers in a whimsical fashion that even actors and engineers can get along more and more agreeably as they increase their appreciation of the other fellows' side of the business.

Get-Together Luncheon Remarks by President Mole

It is encouraging to note that an interest in engineering is developing quite generally among motion picture people who have not had technical training or experience. Evidence appears in many places — in plans of motion picture interests to appear before the Federal Communications Commission in the matter of theater television — in current efforts to produce stereoscopic motion pictures for theater release — in the first steps toward extending the field of view of theater patrons through changes in screen design or illumination of the surrounding area — and in widespread introduction of new or enlarged facilities for release printing in color. Another significant indication of the new interest in engineering is the all-industry research program proposed last winter by Dr. L. A. du Bridge, President of the California Institute of Technology.

The motion picture industry need not wait for the institution of an extensive research program, however, before further progress can be made along technical lines. A great deal can be done on a small scale. Each manufacturer of equipment, each producer of motion pictures, and each exhibitor who possesses an engineering or technical department can conduct his own development program.

Young engineers can be hired to bring new blood into an old organization, and promising students can be employed during summer vacations. Many students would be glad to take temporary jobs on a trial basis, with the chance for full-time work after graduation. The more apt students might well be given scholarships and encouraged to pursue a course of study relating directly to a particular industrial problem.

Other steps which can be taken toward the same goal include the placing of development contracts with commercial research organizations.

Our Society serves to coordinate those activities of the industry that relate directly to technical standardization and interchangeability. It also conducts studies

designed to assist entire branches of the industry in learning more about their technical operations. Through the *Journal*, published twelve times each year, it provides a valuable source of technical data that helps in the orientation of engineers just entering the field.

These are the means for steady substantial technical growth, and they are available at nominal cost.

By working in concert with each other and with the men who manage the business of making and using motion pictures for various purposes, our members provide an effective and valuable service. For that reason the Society deserves the continued active support of all related commercial interests, as well as its members.

Given such backing, the Society will continue to function as a fountainhead of the technical progress which underlies both service and profitable operation in all branches of the motion picture and television industries.

Excerpts From Address by Dr. W. R. G. Baker

Authorized by the Radio-Television Manufacturers Association, the present National Television System Committee is a committee whose members are representatives of organizations broadly interested in and experienced in the television field, or of technical organizations vitally interested in research and development of television, as well as qualified individuals not associated with any organization, association or company.

The Committee is charged with the task of assembling technical data on: (1) the allocation of channels in the ultra-high-frequency band; (2) procedures enabling the FCC to lift the "freeze" on very-high-frequency allocation; and (3) basic standards for the development of a commercially practicable system of color television; and it is directed to undertake such additional work as may be indicated to provide more adequate television service to the American public.

Various projects within the framework of the charter of the NTSC are assigned to individual members of the Committee or to technical panels named by the chairman with the concurrence of the vice-chairmen. The members of the panels are drawn from any company, association or organization regardless of affiliation. The only requirement for membership on any panel is recognized skill, interest and ability in the assigned project. When each panel completes an assigned project, it submits a report stating both majority and minority opinions to the NTSC.

The frequency spectrum and particularly that portion utilized in communication, is one of our national resources, as much a national resource as are the supplies and reserves of crude oil or forests or mineral ores. Although the frequency spectrum transcends all geographical or political boundaries, most of the spectrum is of its greatest value within such borders, and therefore can be considered a physical asset of political entity.

Misuse or inefficient use of the spectrum is as great a physical loss as destruction of our other natural resources. And efficient use of the spectrum is difficult to achieve for these reasons:

(1) The spectrum has physical limits. At any one period in the development of the electronic art, only a stated amount of information can occupy the spectrum.

(2) The "lock and key" element is present in every use of the spectrum. Receiving equipment is useless without transmitting equipment and vice versa. Development of the two elements must proceed simultaneously.

(3) Economics often prove a greater factor in governing rate of development than does scientific knowledge. The cost of moving a service from one section of the spectrum to another may be so great that it is not, at any stated time, in the public interest to make the move even though it would result in efficiencies throughout the entire spectrum.

Although the Federal Communications Commission maintains its own group of technical experts, the competition inherent in a private enterprise and within industry — and I'm sure you all will agree there is no industry more competitive than the electronics industry — would normally be an obstacle to the FCC

obtaining free access to the latest technical information, and particularly information concerning promising avenues of developmental research.

It is also true that in a competitive business you may have persons or concerns who will fight more vigorously for acceptance of an idea, or a development, than will others with equally acceptable ideas or developments. To reach a point closest to a correct evaluation of ideas or developments, to make such information available to the FCC, to help focus research and development toward the quickest solution of a problem, an organization like the National Television System Committee is necessary.

In 1939 the FCC held a hearing to determine whether it was practical to establish standards for monochrome television. This hearing developed two important facts. First, monochrome television had been developed to a point where from the technical viewpoint, commercialization was a distinct possibility. Second, at the hearing the industry had demonstrated beyond a doubt that about the only agreement on standards that could be expected was an agreement to disagree.

As of January 15, 1940, the status of the necessary standards for the establishment of a national system of television was substantially as follows: There was no great difference of opinion in the industry with respect to the frequency assignments for television. However, it was clearly apparent that in the industry there was wide divergence of opinion concerning the system standards. Furthermore, there was every indication that unless and until these divergent ideas could be reconciled, progress toward a national system of television was practically at a standstill.

Fourteen months later, after the formation of the first NTSC, full commercial operation of monochrome television began with the approval of the Commission. In this short time the plan for the National Television System Committee had been formulated, the committee assembled, its meetings held, its minutes recorded, technical reports compiled and its final report delivered to the Commission. When the Committee's recommendations were made to the Commission, the complexion of the industry had changed from a discord of counterclaims to a concord of expert opinion which persuaded the Commission to acknowledge its value and to proclaim the art open to the public.

From the time of the first NTSC, color television has been under serious consideration by the engineers of the industry.

You are all familiar with the recent hearing on color television. If one reads the transcripts of the monochrome television hearing preceding the establishment of the first NTSC and the recent color television hearing, certain facts are quite evident:

(1) At the time of the monochrome hearing several experimental transmitters were in use providing television programs to several hundred receivers. There was little if any question on the ability of the industry to provide a commercial monochrome television service from the viewpoint of providing products in the form of transmitters, studio equipment, receivers and certain specialized tubes. The public had ample opportunity to see television and accepted it enthusiastically.

(2) The industry was not faced with any prior obligation such as obsolescence of equipment in the hands of the public. No television receivers had been sold, hence the public had made no investment.

(3) While there was no disagreement within the industry as to the availability of the tools necessary to establish a commercial monochrome television service, there were wide differences of opinion as to the standards on which such service should be based.

The comparable situation with respect to color television was as follows:

(1) There was no extensive experimental broadcasting of color television as was the case with monochrome television. There were very few color television receivers viewing such color television broadcasting. A real question existed as to the ability of the industry to produce color television equipment capable of rendering a commercial service. While there had been some exposure of color television programs to the public, it was not in any sense as extensive as was the case with monochrome.

(2) The public was confronted with the possibility of the investment it had

made in monochrome television receivers being obsoleted. There had been some experience in the case of FM with the mass obsolescence of products in the hands of consumers and it was difficult to look with favor on a repetition of this problem. The entire problem can be summed up in the idea of compatibility with which you are familiar.

(3) There was certainly real and justifiable concern as to the availability of the tools necessary to commercialize color television.

Right or wrong, and personally I think it was right, many engineers felt that insufficient foundation had been laid to warrant selection of a system of color television.

With these facts in mind, it seemed to the RTMA Television Committee that one possibility of resolving the problem was through the formation of a second NTSC. Such action was recommended to the Board of Directors of RTMA and approved.

The NTSC proceeded under its assigned charter but in the late fall of 1950 it became clear that because of the many advances and new proposals relating to color television systems and components, it would be necessary to have an up-to-date appraisal of the state of the art. A special, or ad hoc, committee of the NTSC was established. Some months later, the committee proposed a reorganization of the NTSC to permit a more direct study on the problems and outlined the broad framework of a new standards for color television achieved by combining the best elements of the furthest advances of existing proposals.

The NTSC accepted the ad hoc committee report because it stated a philosophy without specifying details of a color television system. The NTSC technical panels were revised and the work of building around the framework established by the ad hoc committee has gone forward.

The value of the NTSC, to my mind, has been the fact that, in almost every case, when the technical panels sat down to work, those forces which could have distorted their vision, their deliberations, were left outside the door. Engineers and scientists tend to forget their pride in their own idea or research when they are joined in a conference with many others whose technical competence they respect.

Excerpts From Address by James Frank, Jr.

The National Production Authority, under the authority of the Defense Production Act of 1950, created in the Department of Commerce in September 1950, and the Defense Production Administration established in January 1951 were set up to accomplish certain basic objectives. The most important of these were:

(1) To set up programs and procedures which would permit the most efficient rapid progress of the defense mobilization program and, in the event of the necessity of full mobilization, to meet the requirements of the Department of Defense and the Atomic Energy Commission. This objective has been fully met by this time, with emphasis on the fact that a full Controlled Materials Plan has been put into satisfactory operation.

(2) To get the defense mobilization under way so that the military could, as quickly as possible, build up its supply of necessary material.

(3) To the extent possible, to permit the accumulation of critical materials, for which we depend on imports to a large extent, as a stockpile in the event of full mobilization.

(4) To encourage and effect expansion of facilities for the production of raw materials and military products to meet the requirements of the Department of Defense and the Atomic Energy Commission in the event of full mobilization.

(5) To carry out all of the above objectives without handicapping civilian industry to any greater extent than need be.

Let us get straightened out on some confusing issues. The defense mobilization program has been increased, not decreased, and the 1953 Budget before Congress now calls for an increase from 3,500,000 men and women in the armed services to 3,700,000 and, in the case of the Air Force, from 95 Wings under the present program to 143 Wings. The new program also calls for certain increases in the Army, Navy and Marine Corps. As a result of

world conditions at this time, our military and civilian authorities believe that our rearmament goals should be set somewhat higher. At the same time, however, the rearmament program has in fact been lengthened from approximately three years to approximately four years, but we are now talking about the new increased program.

There has been some cancellation of military contracts but not to as wide an extent as some are led to believe by the newspapers. One of the reasons for this is that the armed services at first placed some contracts for military goods for the increased program in the belief that that program would be achieved in three years, rather than four years. When the term of four years was decided on, they cancelled some contracts. Another explanation is that the design of new machine tools, substitution of materials, etc., has required some changes in planning. Furthermore, constantly improving design of weapons calls for the altering of contracts and cutting down or ceasing production of the old types of products.

The amount of material that was returned to DPA by the Department of Defense for the second quarter can be misleading. 25,000,000 pounds of copper returned is 12,500 tons, or less than one-half of one per cent of our annual consumption of copper.

The easing of material shortages is explained by the above minor return of material and the fact that there has been a considerable increase in our production of certain basic metals, as well as electric power, petroleum and the like. For instance, steel production has been increased from 100,000,000 tons a year, pre-Korea, to 109,000,000 tons, and will continue to rise to 120,000,000 tons per year. Aluminum production has increased by 150,000 tons and eventually will be double pre-Korea. Furthermore, the operation of the Controlled Materials Plan has really begun to work and manufacturers are able to book orders with mills when they get such allotments. That has minimized scare buying and has encouraged reduction of large inventories.

However, there are now two serious problems with respect to controlled materials. All of the copper products, as well as nickel-bearing stainless steel, are and will continue for some time, to be in tight supply.

The constant flow of civilian products during the past year, despite material shortages, is a tribute to the ingenuity of engineers such as those represented by this Society. They have affected remarkable conservation in the use of critical materials to permit maximum production of end products. However, at this time, certain vigorous efforts are required to minimize the use of all of the forms of copper and of nickel-bearing stainless steel.

There is definite evidence that the officials of DPA and NPA are anxious to lift controls the moment that they can do so safely. This is evident with respect to rubber, lead, non-nickel-bearing stainless steel, and others. However, we still must travel a long road before we reach the desired stage of decontrol. In the third quarter, direct defense needs will take 18% of all our carbon steel, 35% of our alloy steel, 19% of our copper foundry products, 27% of our copper wire mill products, 46% of our copper brass mill products, and 43% of our aluminum. To some extent, moreover, expanding production of materials in the months ahead will be counterbalanced by expanding military needs.

It is our feeling that until such direct defense needs of any controlled material reaches the level where they are not in excess of 20 or 25% of total supply, they should not be completely decontrolled. It is hoped that certain forms of carbon steel and aluminum may be decontrolled early next year.

Some people have asked whether we are not taking a terrific risk in extending the Defense Mobilization Program from three to four years. Unquestionably there is a calculated risk, based on current world conditions, but it is felt that it would be unwise to break ourselves or cripple our economy with a mad rush in rearmament and then find we had a mountain of weapons rapidly becoming obsolescent. We are gathering strength in an orderly fashion, which will keep us stronger over a longer period of time than if we rushed now into all-out mobilization.

One of the serious problems is military design changes. Such design changes mean improvements. Improvements mean a finer fighting machine. For our

members of the armed forces they mean more offensive power, more defensive protection. It is a hard decision to have to make between freezing designs and pouring out the stuff, or allowing more design changes and slowing up production. If we thought the Soviets were going to attack tomorrow, of course we would freeze and pour it out, but if they did not attack, we would have spent a lot of money, chewed up a lot of much-needed copper and aluminum, and have on our hands a mountain of obsolescent weapons. By allowing for a reasonable number of design changes: we get better weapons in the long run; we use up less material; and we save some money for the bedeviled taxpayer.

Since the establishment of the National Production Authority, a year and a half ago, a strong organization has been developed, basic regulations and controls have been created and improved as a result of close cooperation with industry, the Controlled Materials Plan has been re-created, and is now working effectively, and a system of priorities has been brought into existence. While many difficulties have been encountered and mistakes made, the job has been done. Military production, industrial expansion, and all defense supporting programs are moving ahead at rapid rates. Moreover, the organization, control techniques, and experience, all of which represent tremendous resources, equal to the weapons of war, will stand us in good stead should the necessity for their increased use arise. While all of us hope that this will not be the case we must continue to emphasize the importance of preparedness.

"Chicago" was a very smoothly functioning Convention, due to the cooperative and coordinated efforts of the many Chicago people who worked hard: George Colburn for the Papers Program and the Luncheon and Banquet and C. E. Heppberger for the overall of Local Arrangements. Supporting George Colburn on the procuring of papers were Papers Committee Chairman Ed Seeley and Vice-Chairmen J. E. Aiken, F. G. Albin, G. G. Graham, R. O. Painter (for High-Speed Photography), W. H. Rivers and R. T. Van Niman, with some assists by Editorial Vice-President John G. Frayne.

To get the folks registered and oriented is a real job at each convention and, though high on the list of the many cares of the Society's Convention Vice-President Bill Kunzmann who is always on deck, registration is a major operation — at Chicago well done under Chairman Jim Wassell with a strong assist by Reid Ray and help by Steve Hunter, Ken Mason, Charles Nesbitt, Jack Powers and Paul Ireland.

Public address and recording were the bailiwick of Robert P. Burns who put and kept the Society's equipment completely under control to record a goodly lot of convention discussion, while listening with one ear to the Sound Dept. of Balaban & Katz where he is Director.

I. F. Jacobsen, Projection Supervisor for Balaban & Katz, kept steady control of the convention projection, with F. W. D'Arcy initially responsible for 16mm projection plans. In charge of rounding up the motion picture shorts was L. E. Weber, assisted by R. J. Sherry.

An assist for television papers planning was given by Wm. C. Eddy. Chairman for hotel and transportation arrangements was Wm. C. De Vry. Membership promotion activities were headed by Col. S. R. Todd who is the Membership Committee's Vice-Chairman in Chicago. Ray Gallo, Chairman of the Membership Committee, was on hand with active meetings and planning in the latter part of the week.

Publicity was handled on the spot by Len Bidwell who kept a solid volume of information going out through channels to trade and general press, with some nice, effective help from Mrs. Bidwell. Cohostesses for the Ladies' Program were Mrs. C. E. Heppberger and Mrs. Geo. W. Colburn who presented a highly praised program of which one highlight was a luncheon production of Miniature Grand Opera by Fredrik A. Chramer who presented *Madame Butterfly*, with realistic puppets and with music recorded by the Metropolitan Opera Company.

Committee meetings continued to be an

important part of the week's activities. There were eight engineering committee meetings which have been covered in the May issue of the *Journal* under the usual column "Engineering Activities." In addition to the Membership Committee Meeting mentioned above, there was a papers and editorial meeting under the aegis of Ed Seeley and John Frayne, chiefly to pass on to Joe Aiken the main mantle for the next convention — of which much in detail in the next *Journal*.

Engineering Activities

Color As noted in the February 1952 *Journal*, the four-year limitation term of office required appointment of a new chairman to the Color Committee. To this end, Fred Bowditch, Engineering Vice-President, recently appointed J. P. Weiss of Du Pont to fill the post.

Television Studio Lighting The committee met on June 4, 1952, and further discussed specifications for incident light and brightness meters, amending the former by placing a 10% tolerance on the deviation from a cosine response. Word was received from Photo Research Corp. that they are producing a brightness meter which meets the committee specifications and the committee is eagerly looking forward to an opportunity to study and test it.

A subcommittee on terminology under the chairmanship of Hank Gurin was formed to start activity on this vital project.

Glossary Glossary activity in the past has depended primarily on the activity of individuals and engineering committees whose chief interest lay in specialized subjects and projects. This has produced much useful material but not the industry-wide layman type of glossary that is required. The Engineering Vice-President has therefore established a committee charged solely with the responsibility of bringing out a useful glossary. Bill Offenhauser has accepted the chairmanship of this committee and is looking about for competent and eager members. The Committee will first take inventory of past work and then draw up its plan of attack. It will correlate its activities with similar activities of other societies and call upon all branches of industry and all SMPTE engineering committees for any required assistance. Those interested in participating in the work of this new committee are asked to so advise Bill Offenhauser or Hank Kogel at Society Headquarters.

Television Film Equipment The main order of business at the May 27, 1952, committee meeting was the discussion of the film recording and reproduction dimensions. The committee has been attempting to reach agreement on proposed standards with no success as yet. Differences have cropped up both on the East and West Coasts. One claims an excessive loss of material in the kinerecording process; the other is seeking to increase the size of the reproduced or scanned area. The detailed discussion of these problems is contained in SMPTE 461, a copy of which is available upon request.

In addition, agreement was reached on proposals regarding dimensions of slides and opaques which must now go to a letter ballot of the full committee.

ISO/TC 36 The Technical Committee on Cinematography of the International Organization for Standardization met as scheduled on June 9, rolled up its sleeves and proceeded to do a very workmanlike job. After establishing the order of importance of the various items on the agenda and extending the meeting to three days instead of the two originally planned, the committee broke up into informal work groups for round-table discussion. The areas of agreement and disagreement were thoroughly canvassed (to the degree that time permitted) with a considerable measure of success. The delegates were agreed that an excellent foundation had been laid for international standards activity which could now be fruitfully pursued through correspondence. A more detailed report will be made available to the Society at a later date.—*Henry Kogel*, Staff Engineer

Current Literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer

vol. 33, Feb. 1952

Technicolor Cameras Now Ride the RO Crane (p. 65) *A. Rowan*

Stereoscopic Movies With Any 16mm Camera (p. 72) *J. Forbes*

vol. 33, Mar. 1952

"The Wild North" Introduces MGM's New Ansco Color Process (p. 106) *A. Rowan*

Stereoscopic Motion Pictures, Pt. II (p. 110) *J. A. Norling*

New Resolving Power Test Chart (p. 111)

Bell & Howell Introduces 16mm Magnetic Recorder-Projector (p. 112) *E. C. Hajduk*

British Kinematography

vol. 20, Mar. 1952

A Projector-Family Programme — The FP. 7 Projector — (p. 66) *J. J. Kotte*

Filming Radar (p. 77) *J. R. F. Stewart*

Exposure for Colour (p. 83) *J. H. R. Coote*

International Projectionist

vol. 27, Feb. 1952

Illuminated Screen Surround? No; Rounded Masking Corners? Yes. (p. 18) *R. A. Mitchell*

vol. 27, Mar. 1952

Better Film Care Improves Entertainment, Pt. I (p. 7)

LaVezzi's Newly-Designed Intermittent Movement (p. 16)

vol. 27, April 1952

What's New in Projection Screens (p. 5)

Three-dimensional Projection in Europe (p. 9)

Better Film Care Improves Entertainment, Pt. II (p. 10)

Kino-Technik

no. 3, 1952

Storschallgeber rings um das Mikrophon (p. 56) *E. Leistner*

Die internationale Spielfilm — Produktion aus zwanzig Jahren (p. 50)

Schmalfilm — Theater maschine "Leitz G 1" in drei Typen (p. 58) *E. May*

Der Farbfilm im Atelier, in der Kopieranstalt und im Theater (p. 63) *W. Behrendt*

16mm-Tonfilmprojektoren auf dem deutschen Mark(p. 66)

no. 4, April 1952

Ein neues Kamerasystem für Stereoaufnahmen (p. 74) *H. Lüscher*

Welche Anforderungen stellt das Fernsehen an den Rohfilm? (p. 80)

Eine leistungsfähige 16mm-Bilton-Kamera (p. 84)

Proceedings of the I.R.E.

vol. 40, Feb. 1952

Improvements in Image Iconoscopes by Pulsed Biasing the Storage Surface (p. 146) *R. Theile and F. H. Townsend*

Radio & Television News

vol. 47, April 1952

(Radio-Electronic Engineering Section)

High Speed Image Converter (p. 12) *H. Weil*

RCA Review

vol. 13, Mar. 1952

Performance of the Vidicon, a Small Developmental Television Camera Tube (p. 3) *B. H. Vine, R. B. Janes and F. S. Smith*

The RCA Color Television Camera Chain (p. 11) *J. D. Spradlin*

Image Orthicon Color Television Camera Optical System (p. 27) *L. T. Sachtleben, D. J. Parker, G. L. Allee and E. Kornstein.*

The NBC New York Color Television Field Test Studio (p. 107) *J. R. DeBaun, R. A. Monfort and A. A. Walsh*

Tele-Tech

vol. 11, April 1952

A New All-Purpose Television Camera (p. 38) *A. Reisz*

Tele-Vision Engineering

vol. 3, April 1952

Magnetic Sound and Negative Picture Transmission (p. 10) *R. Conner*

New Members

The following members have been added to the Society's rolls since those last published. The designations of grades are the same as those used in the 1952 MEMBERSHIP DIRECTORY.

Honorary (**H**) Fellow (**F**) Active (**M**) Associate (**A**) Student (**S**)

Abernathy, Lloyd B., Director of Photography, Fotovox, Inc., 286 Monroe Ave., Memphis, Tenn. (**A**)

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CHANGES IN GRADE

Greenfield, J. C., (**A**) to (**M**)
Tickes, Samuel, (**A**) to (**M**)
Wilson, Brown, (**A**) to (**M**)

New Products

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products.

This new Spectra Brightness Spot Meter will soon be available from Photo Research Corp., 127 W. Alameda Ave., Burbank, Calif. It is designed to measure the brightness of a very small area at any distance from 4 ft to infinity, through the use of a vacuum photocell, amplifier and microammeter. All users obtain the same reading of a given area, for the meter is independent of the sensitivity of the observer's eye and requires no matching of brightness.

The size of the area measured is 1°, that is a 1-in. spot at 5 ft, 2-in. spot at 10 ft, etc. The subject to be measured is viewed at considerable magnification through the telescopic sight built into the meter, a circle in the center of the field of view indicating the actual area being measured. The meter is self-contained, having no external power source. It weighs about 5 lb.

To allow handholding the meter and still reading the brightness, a locking-type microammeter is used. The operator pushes a button on the side when the desired area is in the reticule circle and then releases the button again. The meter holds the reading until the button is again depressed.

The sensitivity of the meter is broad, having an overall range from 1 to 1,000,000-ft-L over its five ranges. A logarithmic scale meter is used to accomplish a percentage of accuracy about the same over the entire scale. The photocell is filtered so that its response closely approximates visual response.

Photo Research Corp. has designed the meter with the idea that it will be most useful for measuring brightness from a given position, such as the camera position in cinematography or television, and in measuring screen brightness.

A new 16mm lens series has been announced by the Kinoptik Company of Paris, France, which for several years has had a 35mm series for motion picture and television cameras. Available in C-mounts for standard 16mm motion picture cameras are 20-, 25-, 32-, 50- and 75-mm Kinoptik lenses. They have *T* as well as *f* scales, a new system of equidistant aperture markings, and a six-element design. Shown here is a Kinoptik for 16mm, 1-in., *f*/2 Apochromat in focusing C-mount. Complete descriptions of both the 35mm and 16mm lenses are available from the U.S.A. distributor, Victor Kayfetz, 130 E. 56 St., New York 22, N.Y.

Lantern Slides and How to Make Them is a 37-page reprint booklet of which 26 pp. are from *See and Hear* magazine and written by Mary Esther Brooks of the Bureau of Audio-Visual Aids at Indiana University. In these pages are a wealth of details about techniques, materials and sources, arranged in four chapters and a bibliography. Additional chapters are: (1) "Letter Height and Legibility" by R. A. Sage and reprinted from the *Journal of the Biological Photographic Association;* (2) "Homemade Slides by Photographic Methods" and (3) "Filing Opaque Projection Material" by Harold F. Bernhardt from *The Educational Focus.*

Copies are available, preferably in orders of 50 copies or more, at 20 cents per copy from the Educational Sales Division, Bausch & Lomb Optical Co., 786 St. Paul St., Rochester 2, N.Y.

Back issues of the Journal available: 5 years (1947–51) in perfect condition plus the indexes for 1936–45 and 1946–50 and including the 1949 High-Speed Photography, upon any reasonable offer to Vic Gretzinger, 3547 Suter St., Oakland 19, Calif.

Journals and Transactions available: Of the *Transactions* Nos. 11, 14, 20, 21, 23, 25, 27, 28 and 38; and 22 years of the *Journal* (1930–1951) except for Jan., Feb., Mar. and Apr. of 1934, Jan. and Apr. of 1948, and Feb. 1950; also these extra single copies — Nov. 1930; Jan., Feb., July and Nov. 1931; June 1932; Mar. and Apr. 1933; Dec. 1934; Jan. and May 1935; Oct. 1938; July and Dec. 1940; Oct. 1948 and Jan. 1950. These are available upon any reasonable offer made to: Paul J. Larsen, Assistant to the President, Borg-Warner Corp., 310 So. Michigan Ave., Chicago 4, Ill.

Meetings

72nd Semiannual Convention of the SMPTE, Oct. 6-10, Hotel Statler, Washington, D. C.

Other Societies

National Audio-Visual Association, Convention and Trade Show, Aug. 2–5, Hotel Sherman, Chicago, Ill.

University Film Producers Association, Annual Meeting, Aug. 11–15, Syracuse University, Syracuse, N. Y.

Photographic Society of America, Annual Convention, Aug. 12–16, Hotel New Yorker, New York

American Institute of Electrical Engineers, Pacific General Meeting, Aug. 19–22, Hotel Westward Ho, Phoenix, Ariz.

International Society of Photogrammetry, Conference, Sept. 4–13, Hotel Shoreham, Washington, D.C.

American Standards Association, Third National Standardization Conference, Sept. 8–10, Museum of Science and Industry, Chicago, Ill.

Illuminating Engineering Society, National Technical Conference, Sept. 8–12, Edgewater Beach Hotel, Chicago, Ill.

Biological Photographic Association, Annual Meeting, Sept. 10–12, Hotel New Yorker, New York

National Electronics Conference, Annual Meeting, Sept. 29–Oct. 1, Sherman Hotel, Chicago, Ill.

Optical Society of America, Oct. 9–11, Hotel Statler, Boston, Mass.

American Institute of Electrical Engineers, Fall General Meeting, Oct. 13–17, New Orleans, La.

American Standards Association, Annual Meeting, Nov. 19, Waldorf-Astoria, New York

Papers Presented at the Chicago Convention, April 21-25

BY SESSIONS

MONDAY AFTERNOON — Television Session

Robert E. Lewis, Armour Research Foundation, Chicago, Ill., "A Color or Stereoscopic Frame-Sequential Television Viewer."

Sam H. Kaplan, Consultant, Chicago, Ill., "Theory of Parallax Barriers."

A. D. Fowler and H. N. Christopher, Bell Telephone Laboratories, Murray Hill, N.J., "Effective Sum of Multiple Echoes in Television."

Fred Barton and H. J. Schlafly, TelePrompter Corp., New York, "TelePrompter, New Production Tool."

J. A. Norling (Committee Chairman), Loucks and Norling Studios, New York, "Report of Stereoscopic Motion Pictures Committee."

MONDAY EVENING — Television Session

Nathan L. Halpern, Theater Network Television, Inc., New York, "Theater Television Progress."

M. C. Banca, RCA Victor Division, Industrial Equipment Section, Camden, N.J., "Industrial Television."

Victor Trad and Ricardo Muniz, Trad TV Corp., Asbury Park, N.J., "Dual Theater Television System."

John M. Sims, General Precision Laboratory, Pleasantville, N.Y., "Installing GPL Video Film in Denver's Broadway Theater."

W. H. Offenhauser, Jr., Consultant, New Canaan, Conn., "Nomenclature for Motion Pictures and Television."

TUESDAY MORNING — Screens and Control of Brightness

D. R. White (Committee Chairman), E. I. du Pont de Nemours & Co., Inc., Parlin, N.J., "Report on International Standardization."

Charles W. Handley (Committee Chairman), National Carbon Co., Inc., Los Angeles, Calif., "Report of the Progress Committee."

Arthur J. Hatch, Strong Electric Corp., Toledo, Ohio, "A-C High-Intensity Arc Slide Projector."

Benjamin Schlanger and William A. Hoffberg, Theater Consultants, New York, and Charles R. Underhill, Jr., RCA Victor Division, Camden, N.J., "The Synchro-Screen as a Stage Setting for Motion Picture Presentation."

W. W. Jennings, W. Wheeler Jennings, Chicago, Ill., and Pierre Vanet, A. Mattey, Paris, France, "A New Direct-Vision Stereo-Projection Screen."

Ellis W. D'Arcy and Gerhart Lessman, De Vry Corp., Chicago, Ill., "Objective Evaluation of Projection Screens."

H. B. Brueggemann, Cinecolor Corp., Burbank, Calif., "Continuous Arc Projector Light Meter."

TUESDAY AFTERNOON — Armed Forces Production

Max Beard and A. M. Erickson, Naval Ordnance Laboratory, Silver Spring, Md., "An Auditorium Specifically Designed for Technical Meetings."

Phillip M. Cowett, U.S. Navy, Bureau of Ships, Washington, D. C., "16mm Motion Picture Theater Installations Aboard Naval Vessels."

W. R. Cronenwett, U.S. Navy, U.S. Naval Photographic Center, Anacostia, D.C., "The Navy's Training Film Production Program."

Charles F. Hoban and James A. Moses, Motion Picture Branch, Army Pictorial Service Division, Washington, D.C., "Cameo Film Production Technique."

P. C. Foote, Bell & Howell Co., Chicago, Ill., and R. E. Miesse, General Scientific Co., Chicago, Ill., "Military-Type Lenses for 35mm Motion Picture Cameras."

TUESDAY EVENING — Magnetic Protection; Film Inspection

M. G. Townsley, H. H. Brauer, J. P. Weber and F. J. Schuessler, Bell & Howell Co., Chicago, Ill., "New Magnetic and Optical 16mm Sound Projector."

Robert Grunwald, Harwald Co., Evanston, Ill., "The Inspect-O-Film Machine."

Carl E. Hittle, RCA Victor Division, Hollywood, Calif., "Automatic Torque Controller for Torque Motors."

E. W. D'Arcy and J. S. Powers, De Vry Corp., Chicago, Ill., "Magnetic Sound Application to 16mm Armed Forces Projectors."

WEDNESDAY MORNING — High-Speed Photography Session

D. Muster and E. G. Volterra, Illinois Institute of Technology, Chicago, Ill., "Rotating-Drum Camera for High-Speed Experimental Work."

Brian O'Brien, Gordon Milne and William Covell, University of Rochester, Rochester, N.Y., "Automatic Printing of High-Speed Image-Dissection Negatives."

J. L. Tupper, Eastman Kodak Co., Rochester, N.Y., "Practical Aspects of Reciprocity Law Failure."

N. W. Rodelius, Armour Research Foundation, Chicago, Ill., and Eugene L. Perrine, Zonolite Research Laboratories, Evanston, Ill., "Methods of Improving Visibility in High-Speed Photography."

WEDNESDAY AFTERNOON — High-Speed Photography Session

C. H. Winning, Du Pont Eastern Laboratory, Gibbstown, N.J., and H. E. Edgerton, Massachusetts Institute of Technology, Cambridge, Mass., "Explosive Argon Flashlamp."

James Cooper, University of Michigan, Aero Research Laboratories, Willow Run Airport, Mich., "Photography in the Wind Tunnel, Including Schlieren and Flame Photography."

Ralph P. Sledge, International Harvester Co., Memphis, Tenn., "Portable Generating Equipment for Use With the Fastax Camera."

THURSDAY AFTERNOON — Color and Laboratory Session

John Stott (Committee Chairman), Du-Art Film Laboratories, Inc., New York, "Laboratory Practice Committee Report."

Robert C. Lovick, Eastman Kodak Co., Rochester, N. Y., "Exposure of Kodachrome Sound Tracks for Optimum Quality.

Robert C. Lovick, Eastman Kodak Co., Rochester, N.Y., "Densitometry of Silver Sulfide Sound Tracks."

F. P. Herrnfeld, Frank Herrnfeld Engineering Corp., Culver City, Calif., "Integrating-Type Color Densitometer."

A. A. Duryea, T. J. Gaski and L. Mansfield, Pathe Laboratories, Inc., New York, "Negative-Positive Color Processing by Pathe."

THURSDAY EVENING — General Session

Mauro Zambuto, Scalera Films, Rome and Venice, Italy, "Foreign Language Dubbing."

Thomas T. Hill, The Edwal Laboratories, Inc., Ringwood, Ill., "Nonsilver Photographic Processes."

H. L. Baumbach, Paramount Pictures Corp., Hollywood, Calif., "Effect of pH Upon Photographic Developer Activity."

John K. Hilliard (Committee Chairman), Altec Lansing Corp., Beverly Hills, Calif., "Sound Committee Report."

Otto Bixler, Magnecord, Inc., Chicago, Ill., "Commercial Binaural Tape Recorder."

FRIDAY MORNING — Sound and Editing Session

Chester E. Beachell, The National Film Board of Canada, Ottawa, Ontario, Canada, "Simplified Preamplifier With High Gain, Low Distortion, and Exceptional Dynamic Range and Frequency Response."

O. L. Dupy, Metro-Goldwyn-Mayer Sound Dept., Culver City, Calif., "A Method of Direct-Positive Variable-Density Recording With the Light Valve."

Chester E. Beachell and G. G. Graham, National Film Board of Canada, Ottawa, Ontario, Canada, "Dual-Purpose Optical Sound Prints."

R. M. Savini, Editola Corp. of America, New York, "The Editola Film Editing Machine."

Richard H. Ranger, Rangertone, Inc., Newark, N.J., "Tape-to-Film Editor."

Richard H. Ranger, Rangertone, Inc., Newark, N.J., "A Versatile Camera Car and Recording Unit."

FRIDAY AFTERNOON — New Equipments Session

A. L. Holcomb, Westrex Corp., Hollywood, Calif., "Three-Phase Power From Single-Phase Source."

Chester E. Beachell, The National Film Board of Canada, Ottawa, Ontario, Canada, "Multiple-Camera Control and Automatic Synchronizing System."

Benjamin Berg, Benjamin Berg Agency, Hollywood, Calif., "Professional Motion Picture Camera Which Utilizes Both 16mm and 35mm Film."

Lee R. Richardson and William N. Gaisford, Richardson Camera Co., Hollywood, Calif., "Follow-Focus Device and Camera Blimp for 16mm Professional Camera."

Willy Borberg, General Precision Laboratory, Pleasantville, N.Y., "Buckle Reduction in 35mm Film."

SMPTE Officers and Committees: The roster of Society Officers and the Committee Chairmen and Members were published in the April *Journal*.

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